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Effects of irrigation water salinity on forage growth and qualities of some salt tolerant species under UAE conditions

Mahmood Abdul Razaq Belselah

United Arab Emirates University
Deanship of Graduate Studies
M.Sc. Program in Environmental Sciences

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By

Mahmood Abdul Razaq Belselah

A thesis

Submitted to the Deanship of the Graduate Studies

United Arab Emirates University
In Partial Fulfillment of the Requirements
for the Degree of Master of Science in the Environmental Sciences

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2003/2004

Statement by the Author

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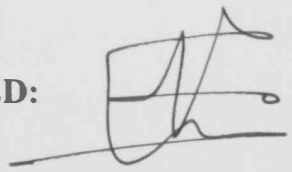
SIGNED: 

Dedication

To my Parents, my wife, brother, and sisters, I would like to thank them in helping and supporting me in my research until the end.

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It is my deep pleasure to thank all of the people that have helped me in my research, either directly or indirectly. I would like particularly to thank the people listed below:-

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   b. Dr. Abdulla Al-Dakheel (International Center for Biosaline Agriculture).
   c. Dr. Fatima Al-Ansari (United Arab Emirates University).
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   c. Dr. Ahmed E. Osman (International Center for Agricultural Research in the Dry Areas-Dubai), member.

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   b. Dr. Ghalib Al-Hadramy.
   c. Mr. Adel Ismael.

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العنوان: تأثير الري بالمياه المالحة على النمو والنوعية لبعض النباتات المقاومة للملوحة تحت ظروف دولة الإمارات العربية المتحدة.

Title: Effects of Irrigation Water Salinity on Forage Growth and Quality of Some Salt-Tolerant Species under UAE Conditions.

ABSTARACT: Experiments were conducted at the International Center for Biosaline Agriculture (ICBA) in Dubai to evaluate the growth and productivity of some locally grown grass species; Rhodes grass (*Chloris gayana* L.) var. Katambora, Pioneer, and Callide; and Panicum grass (*Panicum maximum*) var. Green, and Gatton over a range of irrigation levels (1 gal/hr and 1.3 gal/hr), and water salinity (5dS/m, 10dS/m, and 15dS/m). The effect of different quality of water in respect to the salinity levels would provide information about water use efficiencies and soil salinity over a period of time. Growth and biomass productivity of the test species were periodically monitored and measured for every harvest (plant height, total tiller no., leaf length, internodes length, total fresh weight per m^2, total dry weight per m^2, leave dry weight per m^2, stem dry weight per m^2, leaves fresh weight per m^2, stem fresh weight per m^2, leaf area per m^2, and fertile tillers no. per m^2). Forage quality of these species were evaluated to determine organic (protein, ADF (acid detergent fiber) and NDF (neutral detergent fiber), Dry matter, and Ash) and inorganic contents (Ca, K, Na, Cl, and Mg) of the harvested materials. In order to assess the effects of salinity irrigation water on salt accumulation, soil samples were collected at different depths of the soil (30 cm and 60 cm) from various sampling spots of the trial and analyzed for salt content, and correlated with forage productivity and quality. Results showed

that some of the plant measurements were not affected by salinity, although it has shown resistance to salinity. For example, at cut no (2), at irrigation 1.3 gal/hr, Rhodes grass (Callide) has a fresh weight of 1421 g per m^2, 1205 g, 1086 g, at salinity levels 5, 10, 15 dS/m, respectively. The above results showed that the plant was significantly affected by salinity ($P > 0.05$) and slightly decreased its fresh weight while the salinity increased three times. In conclusion, plant was significantly affected by salinity, and in the mean time it has produced a proper fresh weight. There was significant difference between cuts, cultivars within the same cut or other cuts, according to interaction with the environment, or the implemented salinity or irrigation level.

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Introduction

The agricultural use of saline water and salt-affected soils can benefit many developing countries, because if it succeeds it can save on the use of fresh water for agricultural production particularly for forage production. International Center for Biosaline Agriculture strategic plan (2000-2004) stated that" large part of the Islamic world is arid, with limited freshwater resources. The Near East region, in particular, is one of the driest regions in the world. The 29 countries in the region account for 14 % of the world's land area and are home to 10% of the world's human population, yet the region has only about 2 % of the world's renewable water resources."

Salt-tolerant plant can utilize land and water unsuitable for salt-sensitive crops for the economic production of many aspects such as, fuel and other products. Halophytes that grow in water or soil containing a large amount of salts can grow very well in places which are not suitable for other plants. Salt occurs naturally in all soils. Rain dissolves the salts, which then goes through streams and rivers to the sea. Where rainfall is little or there is no quick route to the sea, some of this water evaporates and the dissolved salts become more concentrated. In arid zones, this can result in the formation of salt lakes or in brackish groundwater, and salinized soils. In the developing countries, and due to poor irrigation practices, there are millions of hectares of salinized farmlands. These lands would require a large amount of water to take away the salts in order for other plants to grow. However, there may be useful salt tolerant plants that can be grown without difficulty. In order to improve soil characters and reduce erosion, salt tolerant plant can be grown. Moreover, many arid areas overlie saline aquifers ground water that contains a very high concentration of salts. Through the developing world, there are also extensive coastal deserts where seawater is the only water available. "Although growing crops on sand and salty water is not being prospects for most farmers, for saline

agricultural they can complete each other. The disadvantages of sand for conventional crops become advantages where saline water and salt tolerant plants are used" (San Pietro, 1982). Sandy soil known for its permeability to allow water to penetrate very quickly and smoothly which means that, the salt content near the root zone will be low.

Sandy soils on the other hand, are very low in nutrients needed for plants growth and it has a high rate of infiltration. Six of the sixteen mineral nutrients needed for plant growth are available in sea water with different concentrations suitable for plants. At the same time, the rapid infiltration of water through sand reduces salt build up in the root zone when seawater is used for irrigation. The high aeration quality of sand is also valuable. This characteristic allows oxygen to reach plant roots and facilitates growth. Careful use of sand, seawater, sun and salt tolerant plants represents valuable opportunity for many developing countries.

The amount of salt tolerated by plants differs from one plant to another. Yields are subject to numerous agricultural and environmental effects. Interactions between various soils, water and climatic factors affect the plant ability to tolerate salt. Some salt tolerant plants and halophytes require fresh water for germination at early stages, but once they reach a specific height they can tolerate a greater amount of salt either in water or the soil itself.

Mass (1986) stated that traditional farming efforts usually focus on modifying the environment to suit the crop. In saline agriculture, however a different way was used to allow the environment to select the crops. Tyagi and Sharma (2000) suggested that "Matching salt-tolerant plant with desirable characteristics to the available saline resources."

Shay (1990) mentioned that many barren lands can be productive by growing salt tolerant crops and employing special techniques using this store of brackish water for irrigation. Agricultural development naturally takes place first on the best land. But as

the demand for the products of land- food- fuel and other things increases, the necessity to make maximum use of land which is less suitable for agricultural.

Hussain (1968); Khan and Rana (1969); Hussain *et. al* (1979) and Haider and Farooqi (1975) stated that agricultural production is totally dependent on water but that quantity of fresh water is not sufficient to meet future crop water need. An alternative is brackish water, but its continuous use without proper management will deteriorate soil properties.

Salt tolerant plants have undergone various kinds of morphological, physiological and biochemical modifications during evolution which enables them to grow under high stress conditions. The above mentioned studies demonstrate the ability of some plants to grow under salt stress. Most known species are grasses like Rhodes grass (*Chloris gayana L.)* and Panicum *(Panicum maximum)* which will be described below.

Rhodes grass and Panicum grass are believed to resist salinity up to 15 dS/m, which means that these kinds of grass forages can produce high production ratio grown in saline soils, or irrigated by saline water. As per what have been done in this research, the Rhodes grass and Panicum grass have proofed that it can resist the salinity exposed to, and to produce high yield, at the same time it have decreased in yield and other measuring parameters in small amounts.

For resolving this problem (the scarcity of fresh water), there should be research on a non-traditional farming that uses high salinity tolerant plant which have and saline water resources. International Center for Biosaline Agriculture strategic plan (2000-2004) explains this as "saline and brackish water resources are far more abundant than fresh water and little used at present. Bringing these resources into sustainable productive use will offer opportunities to increase food security in many of the neediest regions of the world".

Objectives:

1- To study growth response and biomass productivity of some salt tolerant grasses subjected to difference levels of salinity and quantity of irrigation.

2- To determine the forage quality of the tested species in reference to salinity and quantity of irrigation water,

3- To determine the relationships between different soil and water factors to forage quantity and quality.

Plant Description

Rhodes Grass *(Chloris gayana* L. Family: Gramineae): A sub-humid tropical and sub-tropical perennial grass used primarily in pastures for grazing, hay and silage. Mannetje and Keresten (1992) reported that "Rhodes grass is stolone (various with cultivars creeping or occasionally tufted perennial grass). Its stem is fine and leafy, plant height ranges from (0.5 m) to (2 m) high. (Figure 1-a & Figure 1-b).

Bogdan (1977) reported that "Rhodes grass is native to east, central and the eastern part of west and Southern Africa." It was introduced to a wide region of Africa, United States, Australia, Central and South Japan, South Asia, and other countries in the beginning of the 20^{th} century.

Cultivars:

- **Giant Rhodes grass (Callide):** Robust with thick stems, it has a high productive rate with the ability to resist drought, and it has many local names like "Mpwapwa, Knongwa, Callide" in different parts of the world.
- **Katambora:** It has a leafy dense plant originated from the Zambezi River in Zimbabwe with the ability to resist nematodes.
- **Mborara:** This plant is native to Uganda, which has high productivity and high seeds production.
- **Pioneer:** It is the first Rhodes grass introduced to Australia and it is characterized with early flowering.
- **Masaba**: First introduced into Kenya as "Endebess" but later renamed as mentioned above. It is leafy and productive but seed production is affected by smut.

Optimal temperature:

The optimum temperature for Rhodes is 35 °C but it could tolerate a temperature ranging from 0 °C – 50 °C.

Salinity tolerance: Rhodes grass can tolerate high concentrations of salinity up to 15 dS/m due to its ability to store the salt in its leaves without harm.

Planting method: Seeds should not be sown below (25 mm) because of its sensitivity to high depth. Seeds can germinate within (1-7) days, and the flowers occur through the growing season or at the end of the growing season depending mainly on the cultivar.

Figure 1-a (Rhodes grass)

Figure 1-b (Rhodes grass)

Panicum Grass (*Panicum maximum* Family: Gramineae*):* Tufted and large perennial grass. It has many names depending on the country grown in. It can reach a height of 3-4 m tall with glabrous leaves. It is native to Africa, common in India and other countries. It can grow very well in a temperature ranging between (15 °C- 30 °C). It's a drought resistance and can grow will on a wide range variety of well drained soils. (Figure 2-a & Figure 2-b).

It produces a large amount of fine seed during the growing season, and these seeds can be distributed all over the area because it's light weight, and also it has the ability to survive long periods of drought without any harm. Sowing method is either by spreading the seeds over the area, or by drilling the seeds in a prepared seed bed. The sowing depth should be shallow as described in the Rhodes grass paragraph.

Salinity tolerance: Panicum grass can tolerate up to 15 dS/m of salt content.

Optimum temperature: The optimum temperature for Panicum grass is 15 °C-30 °C.

Figure 2-a (Panicum grass)

Figure 2-b (Panicum grass)

Planting method: Seeds should not be sown below (25 mm) because of its sensitivity to high depth. Seeds can germinate within (1-7) days, and the flowers occur through the growing season or at the end of the growing season depending mainly on the cultivar

Literature Review

In the literature review, researchers will describe their kind of work in this field, especially of searching for alternatives for the sweet water, and the usage of the saline one. Grasses (forage grass) have shown resistant to salinity in many ways, which will be discussed in detail in other sections of the research. On the other hand, other resources will be talking about the organic and inorganic content of the plant which will be described as well.

Hoffman (1984) reported that high crop productivity is possible with saline irrigation waters "if management practices are appropriate and environmental conditions are favorable". Use of saline water or soils in agricultural can benefit many developing countries, because of the lack of fresh water, and the possibility to use saline water. Salt tolerant plants can utilize land and water unsuitable for salt-sensitive crops (glycophytes) for the economic production of food, fodder, fuel and other products.

Ahmed (1982) described the importance of using an alternative to fresh water as "lack of good quality water has rendered (30%) of the land surface as desert or near desert in character". Hence, one of the possible ways out seems to be exploitation of underground water irrespective of its quality and use with or without alternation of its chemical constituents depending upon the nature of its use.

From this point of view, it is important to search for alternatives for good quality water. Since there is a source of underground saline water that can be used for this purpose, and by choosing the right plant species, might be a scope to increase the productivity of a species to unexpected levels. The USDA (2002) described that identifying salt tolerant plants species to grow in salt –affected soils or to be irrigated with saline water may increase crop productivity for owners of salt affected lands.

Rich Koenig and Kitchen (1997) said that "salinity tolerance is influenced by many plant, soil and environmental factors and their interrelationship. Generally, fruits, vegetables, and ornamental are more salt sensitive than forage or field crops. In addition, certain varieties, cultivars or rootstalks may tolerate higher salt levels than others".

Alam, (2001) stated that " if, however, the salinity of soil ranges between 15-20 dS/m (9600 ppm -12800 ppm), it will cause crusted soil and the only source of irrigation is bad quality underground water present at a shallow depth. The majority of plants will be restricted under such highly adverse conditions and only some tolerant plants can be grown."

In Western Australia, Lantzke and Calder (1999) mentioned that "hot dry conditions increase evaporation, thus; concentrating the salts. Under such conditions crops are more prone to damage".

Mannetji, and Kersten (1992) noted the ability of grass to tolerate a range of temperatures as the optimum temperature for grass "Rhodes grass has an optimum temperature of 35 °C for photosynthesis but is tolerant of a wide temperature range (0 °C to 50 °C). It is also more tolerant to lower temperature than other subtropical grasses".

Results from the Central Soil Salinity Research Institute, in Haryana, India showed that" amongst the various application modes, direct application of saline waters can be practiced where salinity of water is such that crops can be grown within acceptable yield levels without adversely affecting the soil health". Tyagi (1998) described the ability of a crop to tolerate salinity and to produce commercial yields as "most agricultural crops differ significantly in their tolerance to concentration of soluble salts in the root zone. It is desirable to choose crop/varieties that can produce satisfactory yields under conditions resulting from saline water irrigation"

Abdul Rashid (2002) also found that grasses can grow in saline conditions and produce sufficient yield. He tested two grasses, Kallar grass (*Leptochloa fusca*) which is well known for growth in sodic and waterlogged soils, and Rhodes grass (*Chloris gayana*). Kallar grass has successfully been used for reclamation of much degraded lands, and is useful with high yields of very palatable and digestible forage. The Rhodes grass variety "Pioneer" has also shown itself to be highly salt tolerant and well adapted to the conditions in the Peshawar valley".

The salinity affects the plants at all stages, but it is different from one stage to the other. Mass (1986) stated that "tolerance at emergence is based on survival, whereas tolerance after emergence is based on decreases in growth or yield. Also Mass (1986) mentioned that "other crops, e.g., barley, corn, cowpea, rice, sorghum, and wheat, are most sensitive during early seedling growth and then become increasingly tolerant during later stages of growth and development". It also believed that a lot of tolerant plants and halophytes are sensitive to salinity at early germination stage, but becomes more resistant as the plant grows bigger and bigger.

Following the germination phase, and the harvesting time comes through, measurements of the plant will be taken especially the organic and inorganic content of the plants tested. Dan and others (2002) describes the importance of analysis of the plant materials for the animal feed as "forage and grain sample differ in their chemical composition and digestibility. These qualities, along with the amount animals eat and the efficiency of their metabolism, largely determine animal performance in terms of meat, milk, and wool production. These estimates can be used in ration balancing to improve animal production and cost effectiveness of rations." Also Jimmy and others stated that "there are 16 nutrient elements that have been proven to be essential for the growth and production of plants. Thirteen of these essential elements, which may be supplied by the soil or supplemented by fertilizers, are generally divided into two groups (macronutrients and micronutrients).

Materials and methods

This research was conducted at the International Center for Biosaline Agriculture (ICBA) farm just about 20 kms from the city of Dubai in the United Arab Emirates on Al-Ain Dubai highway:-

1- Longitude: 25 05′ 44 N

2- Latitude: 55 23′ 32 E

3- Elevation: 32 m above sea level

4- Al-Ruwayah- UAE

5- The experimental site was consisting of many sub plots with sandy soil, which requires amounts of organic fertilizers to make the characteristics of the soil better.

Five forage species were evaluated at three salinity levels and two irrigation levels. Forage quality produced was subject to feeding suitability. Different parameters were assessed to test whether forage crops can resist salinity and can produce a high quality and quantity crop under local conditions of the UAE. The result was analyzed by using the "SAS" analysis program. These results provide information about the plant situation during the growth and the interaction between them, and also whether the salinity affected the plants or not?

The five crops used were as follow:-

1- ***Chloris gayana*** cultivar" Katembora"

2- ***Chloris gayana*** cultivar "Pioneer"

3- ***Chloris gayana*** cultivar "Callide"

4- ***Panicum maximum*** cultivar "Green"

5- ***Panicum maximum*** cultivar "Gatton"

The experiments are described in details as:

1- Preliminary materials and methods.

2- Field materials and methods.

3- Lab testing for plant and tissue materials and methods.

Preliminary materials and methods

The experiment was designed as split-split plot design with three replications as follow:-

1- Main plot: Salinity: Three levels.

2- Sub-plot: Irrigation (Two levels).

3- Sub-sub-plot: species/var. (5 sp./var.).

Lab test experiment:

A small test was carried out to see if the plants will resist the salinity at the germination stage or not, and also to consider which cultivars of the following will be used in the field experiments. The cultivars are listed below:

1- ***Chloris gayana*** cultivar "coated-katembora"

2- ***Chloris gayana*** cultivar "boma"

3- ***Chloris gayana*** cultivar "katembora"

4- ***Chloris gayana*** cultivar "pioneer"

5- ***Chloris gayana*** cultivar "callide"

6- ***Panicum maximum*** cultivar "gatton"

7- ***Panicum maximum*** cultivar "Green"

Plants were grown in 63 Petri-dish (9 cm) for the whole experiment, and divided by the number of species (7) and number of salinity levels which are (5,10 and 15 dS/m). Each 3 Petri-dishes were planted by one of the cultivars and

irrigated by a different level of salinity and replicated 3 times, which gave a total of 63. The experiment was repeated four times to make sure that the results are correct. The seeds in the Petri dish where monitored and irrigated to check for seed germination. (Figure 3-a & Figure 3-b).

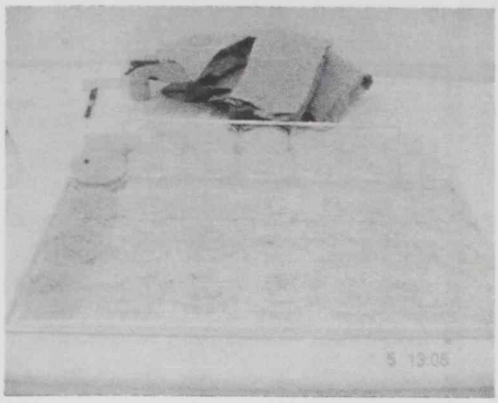


Figure 3-a (Petri dish of the plant trials in the lab) Figure 3-b (petri dishes in the growth chamber)

Field experiment:

Seeds were weighed and 3 grams from each species were packed in sealed plastic bags as follow:-

Three grams of cultivars seeds multiplied by 18 times which resulted in a total of 54 g for each species and "5 g of Katembora" species multiplied by 18 which resulted in a total of 90 grams due to its heavy weight.

Each group of bags which belongs to one of the salinity levels were separated from the others and labeled for the name of the species for salinity level and the irrigation level as well. Seeds were transferred to the field for planting.

Field experiment (materials and methods)

Field experiments were carried out as follow:-

- Land was prepared by leveling, adding the organic fertilizers to increase the soil water holding capacity, and also to improve the soil characteristics at the rate of 35 tons/ha. (Figure 4-a & Figure 4-b).

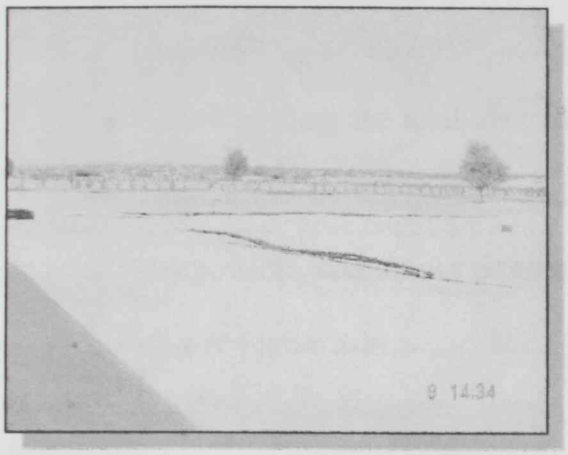


Figure 4-a (land before preparation)

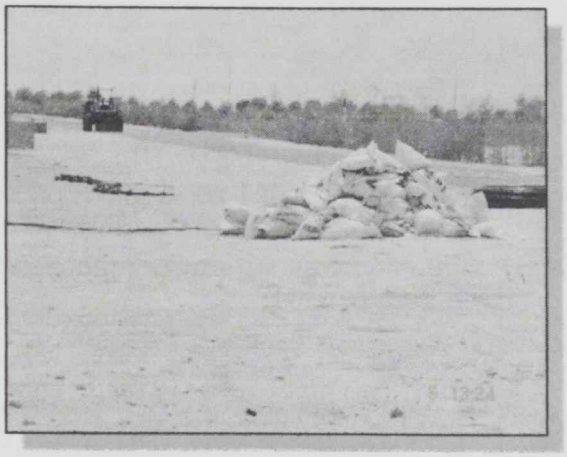


Figure 4-b (land before preparation)

- The land was divided into 90 plots, 3 meters a part, for each species. The distance between each dripper was 30 cm and between the rows was 50 cm.
- Pipes, in the field, were designed to be 15 m in length. Six pipes were used with two irrigation levels in each replicate. Three replicates at each salinity level which will be a total of 108 pipes in the whole field area.
- The experiment was irrigated by using an automatic irrigation mixing system. This kind of system, mixes the salt water and the sweet water to get the proper salinity required. The amount of water used for the experiment was 1 gal/hr, and 1.3 gal/hr .
- Seed bags were distributed over the field according to layout map which describes the location of each species separately.

- Date of planting was 3/6/2001 and it was done by drilling a line along each pipe and the seeds were planted and covered by a thin layer of soil for increas chance of germination.
- Each group of pipe line in the full was planted with 5 species. They were separated by a small gap for decreasing the chance of mixing the seeds together.
- After sowing, the total area was covered by "Agryl" to avoid the direct sun light effect during summer and to maintain the soil moisture content as much as possible, and also to protect the seedlings form the direct sun light. (Figure 5-a & Figure 5-b).

Figure 5-a (land after fitting the irrigation system)

Figure 5-b (land after planting and covering with the agrel)

- Plants started to germinate after 4 days of sowing, because of high temperature. The cover was removed later to allow the plants to grow normally.
- Rhodes grass germinated very well, but the panicum grass started to die (very small size) and some lines didn't germinate at all. The affected lines were sown with the same seeds.
- Because of re-sowing of the seeds, there was a difference in the height between the cultivars in the field. The experiment continued until the plants reached a

certain height (around 30 cm in height). The first cut was done on 12/8/2001 to make the plants uniform one height before applying the salt treatment phase.

- Salinity treatment started on 18/8/2001 at three salinity levels (5-10-15 dS/m). The treatment with the irrigation of fresh water. All of the plots should take the same treated before harvesting.
- The first cut of the plant started on 16/9/2001 and ended at 13/10/2001. This cut was not put together with rest of the cuts (2-3-4) because of problems faced the harvesting like huge number of samples that should be taken, and also to the way of taking the measurements like drying. This kind of obstacle has been considered during the rest of the cuts to get the proper measurements, and to make the harvesting period as shorter as possible.
- The rest of the cuts were done as follow:-
    1. Second cut started on 27/11/2001 and ended on 1/12/2001
    2. The third cut started on 2/2/2002 for Green Panicum species only and the rest of the samples where being cut on 13/3/2002 until 25/3/2002.
    3. The fourth cut started on 25/4/2002 only for Green Panicum species as mentioned previously, and the rest of the field was done on 8/6/2002.
- All samples were taken and kept in paper bags, and taken directly to the laboratory and kept in the refrigerator to minimize nutrient change.
- Water samples were taken from different locations in the field to check the salinity status. (Figure 6-a & Figure 6-b).
- Soil samples also were taken, from every plot at two different profiles (30 cm and 60 cm) to check for the salt accumulation in the root zone.
- Chemical fertilizers have been added to the field after every full cut as follow:

1. NPK (30-10-10) at the rate of 4.5 kg for the whole area at the rate of 40 g for each line (15 m) long.
2. Potassium Nitrate at the rate of 5.5 kg for the whole area at the ratio of 50 g for each line (15 m) long.

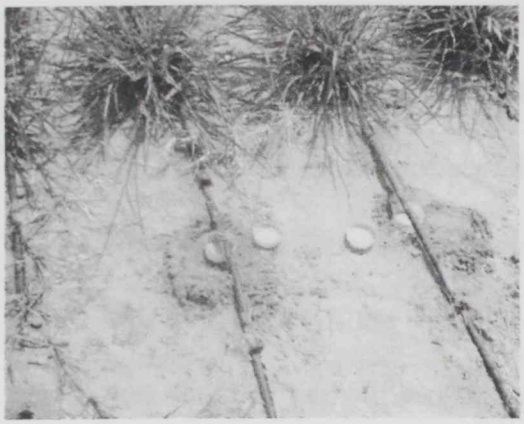


Figure 6-a (water sampling in the field)

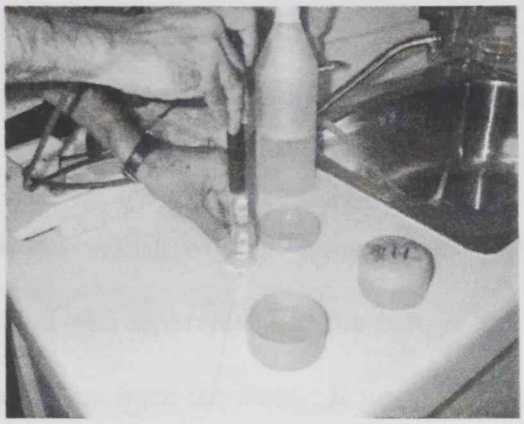


Figure 6-b (water testing in the lab)

Measurements and testing

Measurements and testing started directly after the samples collection and was carried out as follow:-

1- Plant growth and development.

2- Plant drying, crushing, and grinding.

3- Soil and water analysis.

4- Plant tissue analysis.

All of the above points will be described in full detail. Part of analysis was conducted at ICBA and the rest of it was carried out in the University Central Labs Units (CLU).

Plant growth and development:

Plant measurements were divided into many sub-categories depending on the main characteristics of the plant, as follow:-

- **Plant height:** the plant height were taken in (cm) in the field starting from ground level to the last part of spike before cutting the plant.
- **Number of tillering (main-sub-fertile):** this measurement was also taken in the field by counting the number tellers (main stem, sub, and fertile).
- **Fresh weight (leaves-stem-total in grams)**: a wooden frame of about (0.25 m^2 was used), part of the sample collected was separated, and the rest of the sample was weighed without separating the leaves from the stem. It was added together for total weight in the area.
- **Leaf length (cm):** after separating the full leaves from the stem, part of the leaves were taken as a random sample (16 leaves for this experiment) and measured one by one by taking their length starting from the first until the end of the leaf and after that the median.
- **Leaf area (cm^2):** Leaves were taken to the leaf area meter (model: Lycos and made in USA). This device measures the area of the leaves (in cm^2) by entering the leaves into the device one after another.
- **Internodes length (cm):** the separated stems were used to measure the internode length (the length between one bud to the other), (nine) internodes were used for this experiment.
- **Dry weight (g) (leaves-stem-total in grams):** the separated leaves and stems were kept in separate bags, and dried at 65 °C for about one day.

Plants drying, crushing, and grinding:

The plants from the frame were taken to the oven for drying, after taking the fresh weight, for one day on a temperature of (65 °C). Dried plants were crushed using a crusher machine (Made in Germany) to crush the whole plant (leaves and stems). The crushed materials was taken to a grind mill for grinding into fine powder, and kept in paper bags. The paper bags were put into the plastic bags and sealed to avoid any moisture gain.

Soil and water analysis:

Soil and water analysis were done to measure the salinity level both in soil and water. Water analysis (as described in figure no. 6-a and 6-b) was done to make sure that the salinity is in the required range, because there were two sources of water (fresh and salty) and mixed together in order to get where proper salinity, and it was repeated for several times during the research.

Soil samples were collected and kept in plastic bags. Samples were taken to lab for continuing the tests. Part of the collected soil sample was put into the oven at a temperature 110 °C for one day to reduce rid of the microscopic water.

Distilled water was added to dried samples (100 ml to every 20 gram) (extraction ratio 1:5) and shaked for 15 minutes to dissolve all salts. Water extracted from the soil were filtered EC were measured in dS/m, and the result were multiplied by a factor of 5 to correct for dilution (reference: International Center for Biosaline Agriculture).

Plant tissue analysis

Plant tissue analysis was divided into sub-categories as follow:-

a. Fiber analysis "Acid Detergent Fiber" (ADF) and "Neutral Detergent Fiber.

b. Protein analysis.

c. Ash.

d. Dry matter.

e. Ca, K, Mg, Na, Cl.

Fiber analysis:

Fiber analysis was conducted, in order to determine if these samples were good for animal feed.

- **NDF (neutral detergent fiber procedure) (Reference: College of Food Systems-United Arab Emirates University):**

- Weight of the special bags was taken as a blank.
- Another bag was weighed, and then 0.5 g from the plant dried material was added to the bags and sealed.
- Samples were repeated twice for more accuracy.
- Samples were analyzed using "Ankom Fiber Analyzer" which is used to analyze the fiber. The instrument was filled with 2 liters of the NDF solution.
- The digestion phase was set to 75 minute, under a temperature of 100 C°.
- After finishing the last point, samples were washed with boiled water three times (for three minutes for each time) to get rid of all residues in the NDF solution. Bags were washed with acetone in order to get rid of the green pigment or oils in the bags.
- Samples were dried in the oven for 24 hours 70° C.
- Bags were weighed after drying. Results were contributed calculated as follow:-

-Neutral detergent fiber (NDF):

$$\textbf{NDF} = \frac{\textbf{weight of bag and residue after digestion(g) - (empty bag weight} \times \textbf{correction weight)}}{\textbf{Sample weight (g)}} \times 100$$

$$\Rightarrow \text{Correction weight} = \frac{\text{Weight of bag after digestion (g)}}{\text{Weight of empty bag (g)}}$$

- **ADF (Acid Detergent Fiber) (Reference: College of Food Systems United Arab Emirates University):** the ADF is similar to NDF except that it does not contain any cellulose. The procedure is similar to NDF as well. For NDF extraction we add the NDF solution, however for ADF extraction ADF solution was added, and the ADF percentage (%) equation is also the same.

Protein Analysis (Reference: College of Food Systems United Arab Emirates University): Protein is an important component that determine the quality of milk, and it was obtained by the following procedure:-

- A small piece of paper was put on the balance and the balance was tared.
- Part of the plant material was taken (about 0.5 g) and placed on the bag.
- The bag was tied and put in numbered test tubes.
- 5-10 ml of concentrated sulfuric acid (H_2SO_4) was added to the test tube for digestion, and the tubes were placed in an oven at a temperature of 400° C.
- After digestion, tubes were transferred to a distillation unit boric acid was used to collect evolved NH_4.
- Then, the test tubes were transferred to titration phase as the last point. The amount of HCL used for the titration represents the amount of nitrogen in the sample, which will be later expressed by multiplying the nitrogen by a factor of 6.25 (constant number).

$$\text{Nitrogen percentage} = \frac{\text{HCl consumed in titration} \times \text{normality of HCL} \times 0.014 \times 100}{\text{Sample weight (g)}}$$

Protein percentage = nitrogen percentage×6.25

Dry-matter: The procedure for determining dry-matter is described:-

- A small container was taken and weighed on the balance without any sample.
- A plant sample was put inside the small bag (0.5 g) after tarring
- Samples with the container were kept in the oven at a temperature of 105 °C for 24 hours to reduce of moisture.
- The containers were removed after 24 hours of drying and weighed.
- The difference in the weight represents the dry-matter.

Ash: Samples from the same plant materials were placed in a furnace for one day under a temperature 600 °C. The difference represents ash.

Cl-Ca-K-Na-Mg: All of the samples were analyzed using the same methodology (the plasma emission) except for Cl.

Cl analysis procedure: The Cl analysis was measured using two methods:-

A. Extraction with water.

B. Titration.

a. Extraction with water: Approximately 0.5 g of dried plant material was weighed to in a metal weighing funnel and then transfer to a 50 ml flask. 25 ml water was added, and shake for 30 minutes. The solution was filtered two times to remove inert materials, which made it ready to analyze.

b. Titration (Silver Nitrate Method): 20 ml of volume (v1) of sample was pipetted into a conical flask. 1 ml of potassium chromate indicator was added and titrated against standard silver nitrate until the color changed from pale yellow to buff red.

⇒Calculation of results:

$$\text{Chloride (mg/l)} = \frac{35.5 \times V \times N \times 1000}{V1}$$

Where:-

- V⇒volume of silver nitrate.
- N⇒normality of silver nitrate.
- V1⇒volume of sample.

Remark: The above procedure for determining Cl took place at the Central Labs Unit UAEU.

Mg-Ca-Na-K analysis procedure: It is also divided into two phases:

a. Sample preparation (wet digestion).

b. Analysis.

Sample preparation: (5 g) of the sample was weighed and put into a 600 ml-beaker. 25 ml of concentrated HNO_3 was added. The beaker was covered with a watch glass, and boiled gently for 30-45 minutes. The solution was cooled and slowly, 10 ml 72% HCl was added. The solution was boiled very gently, until nearly colorless without allowing the solution to dry. The solution was left to get cool, and distilled water was added to 100ml.

Analysis: Samples were analyzed on an instrument called the "Plasma Emission". Samples were injected into the device, at a temperature of (8000 °C) specter of each metal was diluted and recorded mentioned above. Measurement was repeated for three times and the mean of the results was recorded.

Results and discussion

Results and discussion of the plant growth measurements

The data was analyzed by using the "SAS" analysis program, and the variables for each cut were as follow:-

1. Plant height (cm).
2. Total tiller no (no.).
3. Leaf length (cm).
4. Internodes length (cm).
5. Total fresh weight/m^2 (g).
6. Total dry weight/m^2 (g).
7. Leaves dry weight/m^2 (g).
8. Stem dry weight/m^2 (g).
9. Leaves fresh weight/m^2 (g).
10. Stem fresh weight/m^2 (g).
11. Leaf area/m^2 (cm^2).
12. Fertile tiller no (no.).

Cut no 2

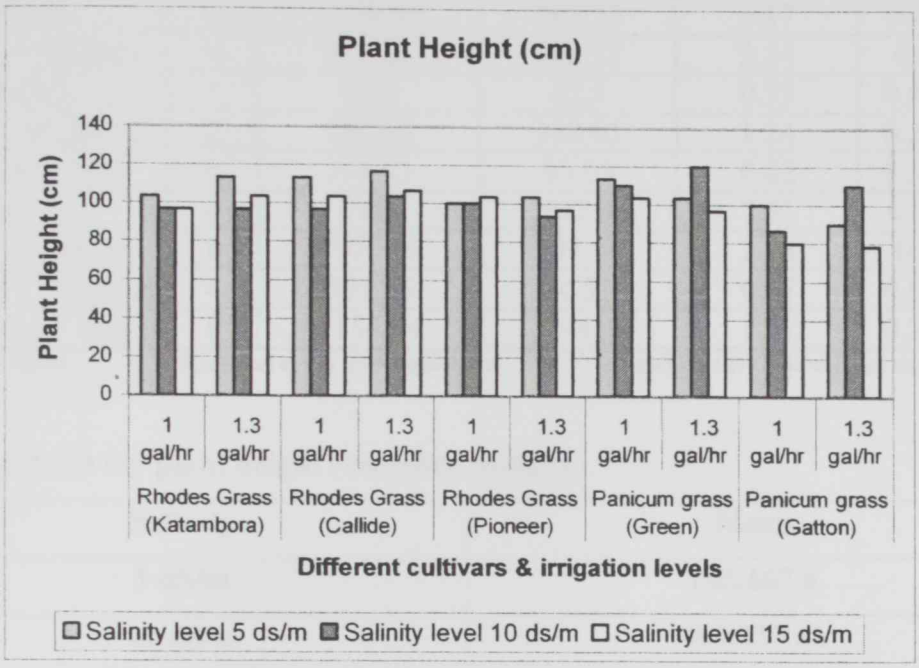
Table (1): Analysis of Variance of Plant Measurements.

Source of variations	F value												
	Degree of Freedom	Plant height	Total tiller no.	Leaf length	Internodes Length	Total fresh weight /m^2	Total dry weight/m^2	Leaves dry weight /m^2	Stem dry weight /m^2	Leaves fresh weight /m^2	Stem fresh weight /m^2	Leaf Area /m^2	Fertile Tillers no.
Model	41	0.0025	0.0006	0.0042	0.0932	0.0001	0.0071	0.0020	0.0021	0.0001	0.2181	0.0001	0.0022
Error	48												
Corrected Total	89												
Replicate	2	0.0142*	0.1609 NS	0.9231 NS	0.1147 NS	0.0741 NS	0.2655 NS	0.7971 NS	0.8939 NS	0.9311 NS	0.8709 NS	0.5890 NS	0.7594 NS
Salinity	2	0.0093**	0.0106 *	0.0029 **	0.4638 NS	0.0001 **	0.0001 **	0.0040 **	0.0001 **	0.0001 **	0.0118 *	0.0001 **	0.1389 NS
Replicate * Salinity	4	0.0896*	0.3138 NS	0.1459 NS	0.7037 NS	0.8774 NS	0.6614 NS	0.6943 NS	0.1519 NS	0.9648 NS	0.9066 NS	0.9732 NS	0.3989 NS
Irrigation	1	0.4611 NS	0.9891 NS	0.3085 NS	0.1482 NS	0.5183 NS	0.9609 NS	0.2622 NS	0.7154 NS	0.2841 NS	0.6322 NS	0.8354 NS	0.5748 NS
Salinity * Irrigation	2	0.2973 NS	0.7551 NS	0.5158 NS	0.1247 NS	0.8274 NS	0.4553 NS	0.8208 NS	0.6270 NS	0.5518 NS	0.9244 NS	0.8876 NS	0.8355 NS
Salinity (rep.*irr.)	6	0.5584 NS	0.1758 NS	0.9890 NS	0.8677 NS	0.1663 NS	0.4180 NS	0.2153 NS	0.0397 *	0.1058 NS	0.3724 NS	0.0554 *	0.1500 NS
Species	4	0.0001 **	0.0001 **	0.0001 **	0.0011 **	0.0001 **	0.0730 NS	0.0001 **	0.0002 **	0.0001 **	0.0426 *	0.0001 **	0.0002 **
Salinity * Species	8	0.0456 *	0.0458 *	0.0727 *	0.3567 NS	0.0028 **	0.3341 NS	0.0137 *	0.1556 NS	0.0001 **	0.1139 NS	0.0001 **	0.0001 **
Irrigation * Species	4	0.6127 NS	0.9827 NS	0.6082 NS	0.7638 NS	0.4701 NS	0.6573 NS	0.9646 NS	0.5663 NS	0.8563 NS	0.5656 NS	0.6024 NS	0.9972 NS
Salinity * Irr.*Spec.	8	0.2788 NS	0.2102 NS	0.7804 NS	0.2202 NS	0.9903 NS	0.6113 NS	0.3742 NS	0.4547	0.9180 NS	0.6412 NS	0.4849 NS	0.5826 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Plant height (cm)

Figure (7): Plant height (cm) of difference cultivars under different salinity levels, and different irrigation level.



Plant height decreased with an increase in salinity. Results showed that under these environmental conditions there was no difference between the species, irrigation, and salinity level. As per the ANOVA table, there were a number of significance effect as well as significant interactions. For example, Rhodes grass (Katambora) was 103.33 cm high at irrigation (1 gal/hr), while Rhodes grass (Pioneer) was 100 cm high in irrigation and Panicum grass gained 100 cm at the same irrigation level. At the same time for some of the species there was a difference between the (1 gal/hr and 1.3 gal/hr) irrigation levels within the same species by increasing salinity levels. For an example, Panicum grass (Gatton) was 100 cm high, 86.66 and 80 cm in sequence in irrigation (1 gal/hr). This shows that the plant might be affected by salinity.

Table (2): ANOVA table for the Plant height (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	10844.72	264.5	2.34	0.0025
Error	48	5433.33	113.19		
Corrected Total	89	16278.05			
Replicate	2	1053.88	526.94	4.66	0.0142 *
Salinity	2	1170.55	585.27	5.17	0.0093 **
Replicate * Salinity	4	971.11	242.77	2.14	0.0896 *
Irrigation	1	62.5	62.5	0.55	0.4611 NS
Salinity * Irrigation	2	281.66	140.83	1.24	0.2973 NS
Salinity(rep.*irr.)	6	558.33	93.05	0.82	0.5584 NS
Species	4	3310	827.5	7.31	0.0001 **
Salinity * Species	8	1976.66	247.08	2.18	0.0456 *
Irrigation * Species	4	305.55	76.38	0.67	0.6127 NS
Salinity * Irr. * Spec.	8	1154.44	144.3	1.27	0.2788 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (3): LSD for plant height (variable: salinity)

Salinity	Mean
5 dS/m	**105.667 a**
10 dS/m	**101.333 ab**
15 dS/m	**96.833 b**

Columns followed by the same letter are non-significant at level 0.05

Table (4): LSD for plant height (variable: species)

Species	Mean
Panicum (Green)	**107.778 a**
Rhodes (Callide)	**106.667 a**
Rhodes (Katambora)	**101.667 ab**
Rhodes (Pioneer)	**99.444 b**
Panicum (Gatton)	**90.833 c**

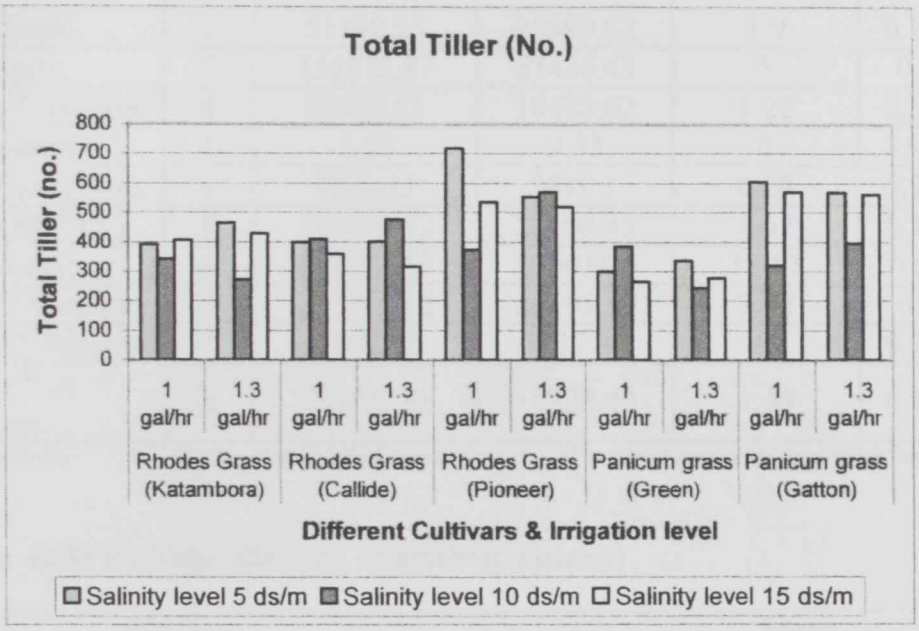
Columns followed by the same letter are non-significant at level 0.05

By looking at the LSD tables provided above for the two variables (salinity and species), there are significant differences between the three salinities. For example, between salinity (1) 5 dS/m and salinity (2) 10 dS/m, there is no difference, but there is a difference in salinity (2) 10 dS/m and salinity (3) 15 dS/m. There was a significant

differences between the replicates, which might be due to several reasons like heat, moisture content of the soil, and growth stage. Species (cultivars) also showed highly significant difference. For example, between Panicum grass (Green) and Rhodes grass (Claide), there is no difference, but between Rhodes grass (Claide) and (Katambora) there is also no difference between their species and Rhodes grass (Katambora). Panicum grass (Gatton) shows a high significant difference the rest of the cultivars.

Total tiller (no.):

Figure (8) :Total Tiller (no.) of difference cultivars under different salinity levels, and different irrigation level.



Tiller number is a measure of plant expansion. Results show that in some cases the Rhodes grass, salinity significantly effected the plant by decreasing the number of tillers. For an example Rhodes grass (Katambora) in irrigation (1 gal/hr) was 392.03 tillers at salinity (5 dS/m), 342.8 at salinity (10 dS/m), and 405.83 no at salinity (15 dS/m).

On the other hand, Panicum grass (Green) shows some increase in tiller numbers. At 5 dS/m salinity in irrigation 1 gal/hr , tiller number was 300.4 in irrigation 1 gal/hr at

salinity 5 dS/m; it increases to 383.3 in salinity 10 dS/m and then decreases again in salinity 15 dS/m. By comparing the two species of Panicum grass (Green and Gatton), we could see a gap between salinity 5 dS/m and 10 dS/m by decreasing number of tillers. Between salinity 10 dS/m and 15 dS/m it showed an increasing number of tillers. This difference might be due to sensitivity of the plant at early stages to salinity. At later growth stage the plant become more and more resistant to salinity.

Table (5): ANOVA table for the Total tiller (no.)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1473215.1	35932.07	2.66	0.0006
Error	48	647259.26	13484.56		
Corrected Total	89	2120474.37			
Replicate	2	51199.25	25599.62	1.9	0.1609 NS
Salinity	2	134872.87	67436.43	5	0.0106 *
Replicate * Salinity	4	65930.51	16482.62	1.22	0.3138 NS
Irrigation	1	2.53	2.53	0	0.9891 NS
Salinity * Irrigation	2	7620.21	3810.1	0.28	0.7551 NS
Salinity(rep.*irr.)	6	127190.72	21198.45	1.57	0.1758 NS
Species	4	692138.65	173034.6	12.83	0.0001 **
Salinity * Species	8	235163.12	29395.39	2.18	0.0458 *
Irrigation * Species	4	5269.82	1317.45	0.1	0.9827 NS
Salinity * Irr. * Spec.	8	153827.38	19228.42	1.43	0.2102 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (6): LSD for Total tiller no. (Variable: species)

Species	Mean
Rhodes (Pioneer)	**544.88 a**
Panicum (Gatton)	**503.29 a**
Rhodes (Callide)	**393.56 ab**
Rhodes (Katambora)	**384.79 b**
Panicum (Green)	**301.11 c**

Columns followed by the same letter are non-significant at level 0.05

Table (7): LSD for Total tiller no. (Variable: salinity)

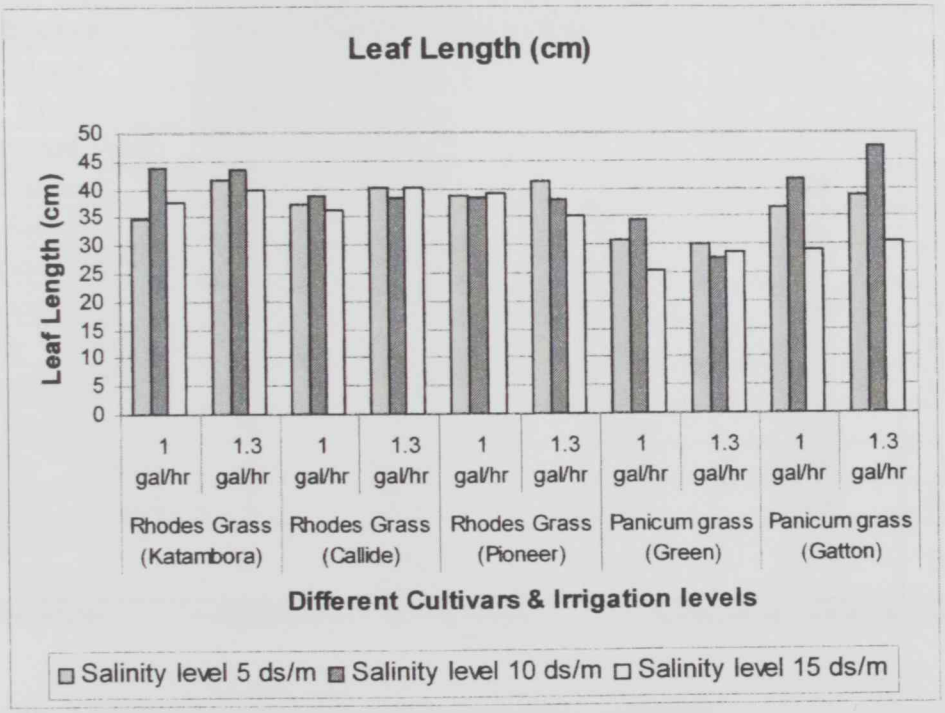
Salinity	Mean
5 dS/m	**473.68 a**
15 dS/m	**424.00 ab**
10 dS/m	**378.90 b**

Columns followed by the same letter are non-significant at level 0.05

The above results shows that there is a significant difference in tiller number between salinity 1 (5 dS/m) and salinity 2 (10 dS/m). The only exception was for salinity 3 (15 dS/m), which had no significant difference with salinity 1 (5 dS/m). Also, for species, there are highly significant when comparing Panicum grass (Green) with the rest of the cultivars. There was no difference between Rhodes grass (Pioneer), Panicum grass (Gatton). Rhodes grass (Katambora) was significant difference from Rhodes grass (Claide).

Leaf length (cm):

Figure (9): Leaf Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Leaf length gives us another indicator to predict the effect of salinity on the plant. Results showed that there was a difference between the three species of Rhodes grass, which means that the salinity did not have that much effect on the plant. For an example, Rhodes grass (Claide) had a leaf length of 37.26 cm in salinity 5 dS/m irrigation 1 gal/hr ,

38.93 cm at salinity 10 dS/m irrigation 1 gal/hr , and 36.06 cm at salinity 15 dS/m irrigation 1 gal/hr . In another example, Rhodes grass (Pioneer) had a leaf length of 38.83 cm at irrigation 1 gal/hr salinity 5 dS/m, 38.5 cm at irrigation 1 gal/hr salinity 10 dS/m, and 39.3 cm at irrigation 1 gal/hr salinity 15 dS/m.

For Panicum grass, there was a significantly difference between the two species, and between the irrigation and salinity within the same species. For example, in Panicum grass (Green) and at irrigation 1.3 gal/hr , it had a leaf length of 30.1 cm at salinity 5 dS/m, 27.5 cm at salinity 10 dS/m, and 28.46 cm at salinity 15 dS/m. By comparing the three outputs together, we can see the difference between salinity 1 and 2, salinity 1 and 3 due to the effect of salt accumulation in the leaves.

Table no. (8): ANOVA table for the Leaf length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	2692.77	65.67	2.22	0.0042
Error	48	1419.61	29.57		
Corrected Total	89	4112.38			
Replicate	2	4.74	2.37	0.08	0.9231 NS
Salinity	2	390.33	195.16	6.6	0.0029 **
Replicate * Salinity	4	211.99	52.99	1.79	0.1459 NS
Irrigation	1	31.32	31.32	1.06	0.3085 NS
Salinity * Irrigation	2	39.7	19.85	0.67	0.5158 NS
Salinity(rep.*irr.)	6	25.93	4.32	0.15	0.9890 NS
Species	4	1305.19	326.29	11.03	0.0001 **
Salinity * Species	8	463.08	57.88	1.96	0.0727 *
Irrigation * Species	4	80.62	20.15	0.68	0.6082 NS
Salinity * Irr. * Spec.	8	139.82	17.47	0.59	0.7804 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (9): LSD for Leaf Length (cm) (Variable: salinity)

Salinity	Mean
10 dS/m	**39.233 a**
5 dS/m	**37.023 a**
15 dS/m	**34.147 b**

Columns followed by the same letter are non-significant at level 0.05

Table (10): LSD for Leaf Length (cm) (Variable: species)

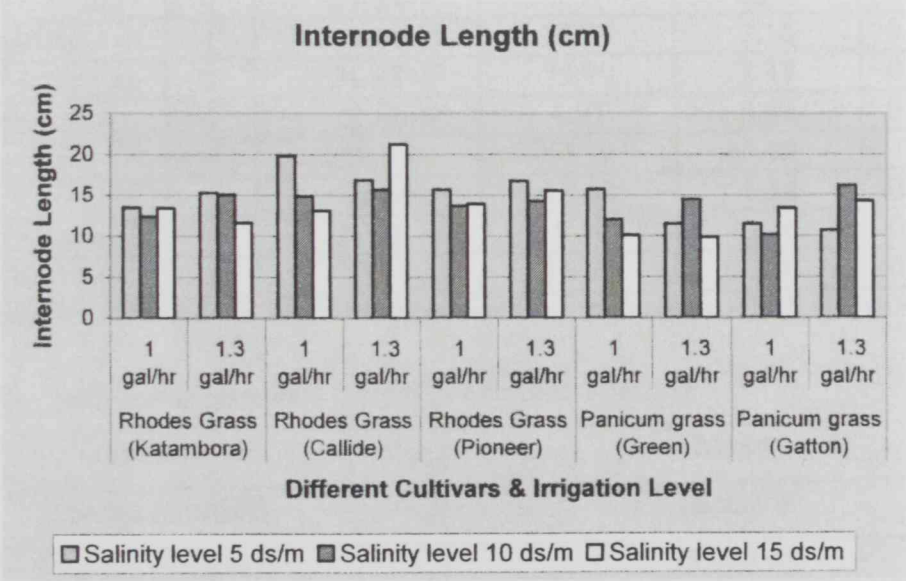
Species	Mean
Rhodes (Katambora)	**40.233 a**
Rhodes (Callide)	**38.561 a**
Rhodes (Pioneer)	**38.489 a**
Panicum (Gatton)	**37.306 a**
Panicum (Green)	**29.417 b**

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was a significant difference between salinity (3) 15 dS/m, and salinity (2) 10 dS/m with salinity (1) 5 dS/m. It was shown for the species showed that there was highly significant difference between Panicum grass (Green) and the rest of the cultivars. This shows that their species has growth response to salinity.

Internodes length:

Figure (10): Internodes Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Internode length is a measure of the effect of salinity, because salinity causes stunted growth in some plants. Results showed that there was a large difference (highly significant in species) in some cases, and in other cases the difference was non

significant. For example, Rhodes grass (Katambora) at irrigation 1.3 gal/hr internode length was 15.3 cm in salinity 5 dS/m, 15.1 cm in salinity 10 dS/m, and 11.63 in salinity 15 dS/m.

Also Rhodes grass (Pioneer) at irrigation 1 gal/hr had internode length of 15.7 cm at salinity 5 dS/m, 13.7 cm at salinity 10 dS/m, and 13.9 cm at salinity 15 dS/m.

On the other hand, Panicum grass (Green) at irrigation 1 gal/hr had an internode length of 15.73 cm at salinity 5 dS/m, 12.03 cm at salinity 10 dS/m, and 10.1 cm at salinity 15 dS/m, which shows that there is a decrease in the elongation of internodes because of the salinity effect. Panicum grass (Gatton) also was not affected by increasing salt level of irrigation water.

Table no. (11): ANOVA table for the Internodes length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	728.5	17.76	1.49	0.0932
Error	48	573.71	11.95		
Corrected Total	89	1302.21			
Replicate	2	54.16	27.08	2.27	0.1147 NS
Salinity	2	18.66	9.33	0.78	0.4638 NS
Replicate * Salinity	4	26.04	6.51	0.54	0.7037 NS
Irrigation	1	25.81	25.81	2.16	0.1482 NS
Salinity * Irrigation	2	51.98	25.99	2.17	0.1247 NS
Salinity(rep.*irr.)	6	29.51	4.91	0.41	0.8677 NS
Species	4	257.59	64.39	5.39	0.0011**
Salinity * Species	8	108.66	13.58	1.14	0.3568 NS
Irrigation * Species	4	22.04	5.51	0.46	0.7638 NS
Salinity * Irr. * Spec.	8	134	16.75	1.4	0.2202 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (12): LSD for Internodes length (Variable: species)

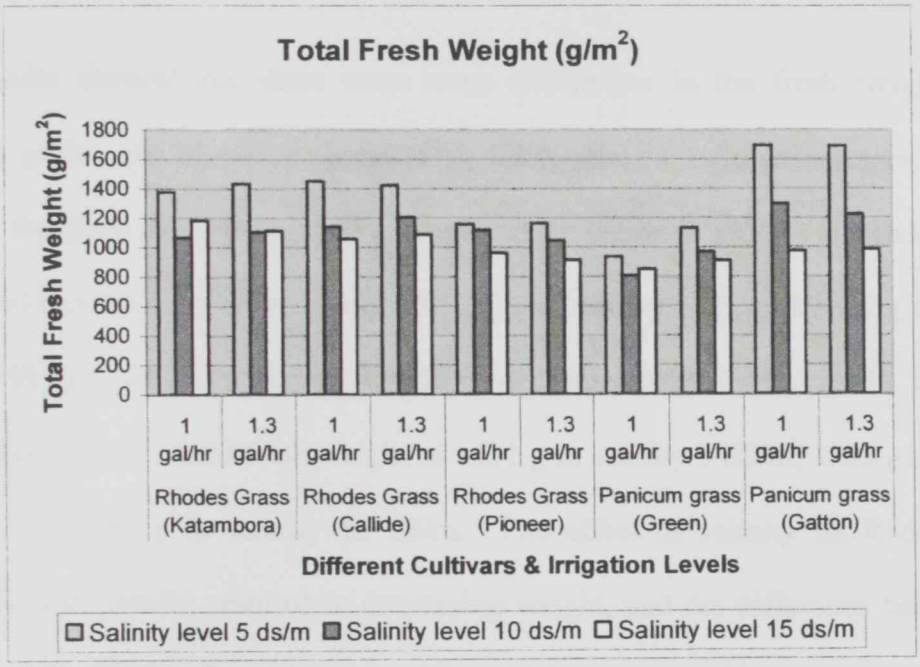
Species	Mean
Rhodes (Callide)	**16.928 a**
Rhodes (Pioneer)	**15.000 ab**
Rhodes (Katambora)	**13.561 bc**
Panicum (Gatton)	**12.717 bc**
Panicum (Green)	**12.283 c**

Columns followed by the same letter are non-significant at level 0.05

The difference between species Rhodes grass (Claide) and the Rhodes grass (Katambora) is significantly affected as in the difference between, Rhodes grass (Pioneer) and Rhodes grass (Claide). Also the significant difference between Panicum grass (Green) and (Gatton) was significant.

Total fresh weight (g/ m^2):

Figure (11): Total Fresh Weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Increasing or decreasing fresh weight is an important indication of the effect of salinity. This is because it is known that the increase in salinity of water or soil, causes a reduction in plants weight. The exact effect also depends on many factors like kind of plant, stage of growth, and environmental interactions.

Pessarakli (1994) stated that "information on the growth stage response to salinity in with a crop is important in adapting suitable genetic and management strategies for saline soils. For example, if a crop is more sensitive during one stage than another, there is an

opportunity to regulate the salinity of irrigation water during the season to minimize salt injury at the sensitive stage".

Also, Pessarakli (1994) said "interactions between salinity, soil, water, and climatic conditions change the plant's ability to tolerate salinity. A basic understanding of the interactions between salinity and environment is necessary for an accurate assessment of salt tolerance. In addition, precipitation, temperature and atmospheric humidity can markedly influence salt tolerance." Mass *et. al* (1977) reported that "many crops are less tolerant when grown under hot dry than under cool humid conditions."

Results showed that there were some differences in the fresh weight in the irrigation 1 gal/hr and 1.3 gal/hr , because logically, once the salinity increases, the fresh weight of the plant decreases. For example, at irrigation 1 gal/hr in Rhodes grass (Katambora) had a total fresh weight of 1377.33 g at salinity 5 dS/m, 1096.2 g in salinity 10 dS/m, 1183 g in salinity 15 dS/m. On the other hand at irrigation 1.3 gal/hr in Rhodes grass (Callide) it had a total fresh weight of 1421 g in salinity 5 dS/m, 1205 g in salinity 10 dS/m, and 1086 g in salinity 15 dS/m. The effect of salinity on Rhdoes grass (Katambora and Callide) resulted in decreasing weight, and the difference between the cultivars was highly significant, because of the salinity.

Panicum grass (Green and Gatton) were affected by salinity and decreased its weight. At irrigation 1.3 gal/hr Panicum grass (Green) gained 1129 g in salinity 5 dS/m, 969 g in salinity 10 dS/m, and 907 in salinity 15 dS/m. Panicum grass (Gatton) at irrigation 1 gal/hr had a total fresh weight of 1694 g in salinity 5 dS/m, 1296 g in salinity 10 dS/m, and 977g at salinity 15 dS/m.

Table (13): ANOVA table for the Total fresh weight (g/ m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	4743643.3	115698.61	4.77	0.0001
Error	48	1163756.73	24244.93		
Corrected Total	89	5907400.03			
Replicate	2	133250	66625.24	2.75	0.0741 NS
Salinity	2	1875952.53	937976.26	38.69	0.0001 **
Replicate * Salinity	4	28967.28	7241.82	0.3	0.8774 NS
Irrigation	1	10269.88	10269.88	0.42	0.5183 NS
Salinity * Irrigation	2	9222.9	4611.45	0.19	0.8274 NS
Salinity(rep.*irr.)	6	233498.23	38916.3	1.61	0.1663 NS
Species	4	1644569.94	411142.48	16.96	0.0001 **
Salinity * Species	8	682566.07	85320.75	3.52	0.0028 **
Irrigation * Species	4	87511.15	21877.78	0.9	0.4701 NS
Salinity * Irr. * Spec.	8	37834.77	4729.34	0.2	0.9903 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (14): LSD for Total fresh weight (g)/m^2 (Variable: salinity)

Salinity	Mean
5 dS/m	**1345.56 a**
10 dS/m	**1097.92 b**
15 dS/m	**1003.10 c**

Columns followed by the same letter are non-significant at level 0.05

Table (15): LSD for Total fresh weight (g)/m^2 (Variable: species)

Species	Mean
Panicum (Gatton)	**1311.00 a**
Rhodes (Callide)	**1227.38 a**
Rhodes (Katambora)	**1213.90 a**
Rhodes (Pioneer)	**1059.08 b**
Panicum (Green)	**932.94 c**

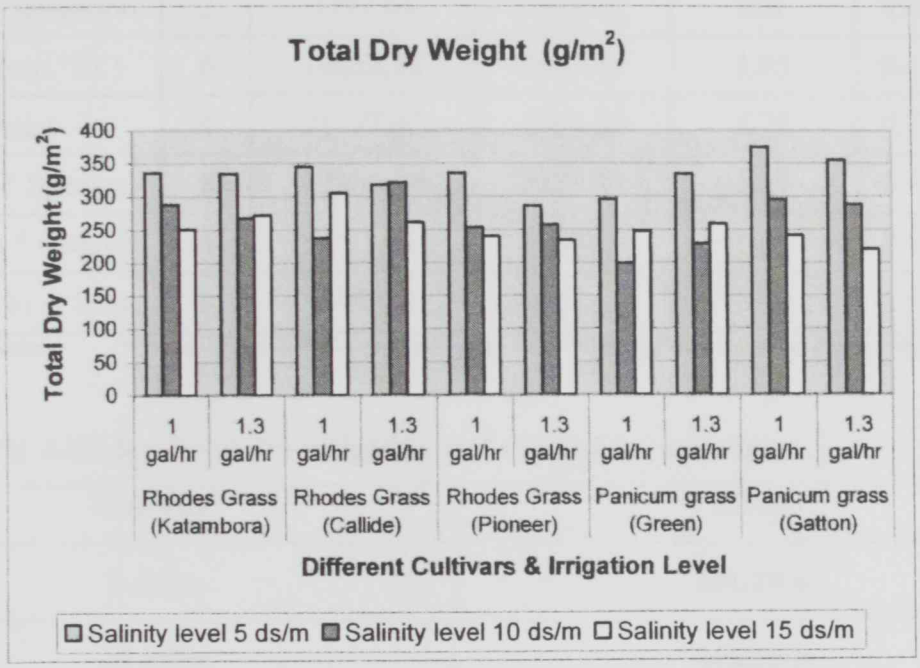
Columns followed by the same letter are non-significant at level 0.05

The LSD for salinity shows that salinity significantly affected the fresh weight. Fresh weight were affected at salinity 5 dS/m, and decreased until it reached salinity 15 dS/m. LSD for different cultivars shows some similarities between different cultivars.

For example, Panicum grass (Gatton) was the least affected by salinity. There is no significant difference between growth and the cultivars in Rhodes grass (Claide), and Rhodes grass (Katambora). At the same time, there was a significant difference between Rhodes grass (Pioneer), and Panicum grass (Green).

Total dry weight (g/ m^2):

Figure (12): Total Dry Weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Dry weight of plants was affected by salinity. Rhoded grass (Katambora) weight 335.8 g at salinity 5 dS/m. 288.66 g at salinity 10 dS/m and 250.33 g at salinity 15 dS/m. The findings also showed that the salinity affected the cultivars (highly significant). In general dry weight of all cultivars was reduced. For example, dry weight of Rhodes grass (Pioneer) decreased ascending starting from salinity 5 dS/m, and ending at salinity 15 dS/m. Panicum grass (Green) was also affected by salinity effect. Panicum grass (Gatton) in irrigation 1.3 gal/hr weight 356 g in salinity 5 dS/m, 287.06 g in salinity 15 dS/m and 220.33 g in salinity 15 dS/m.

Table (16): ANOVA table for the Total dry weight (g /m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	204188.74	4980.21	2.1	0.0071
Error	48	113966.37	2374.29		
Corrected Total	89	318155.12			
Replicate	2	6474.06	3237.03	1.36	0.2655 NS
Salinity	2	108569.77	54284.88	22.86	0.0001 **
Replicate * Salinity	4	5739.52	1434.88	0.6	0.6614 NS
Irrigation	1	5.77	5.77	0	0.9609 NS
Salinity * Irrigation	2	3797.64	1898.82	0.8	0.4553 NS
Salinity(rep.*irr.)	6	14663.52	2443.92	1.03	0.4180 NS
Species	4	21777.47	5444.36	2.29	0.7300 NS
Salinity * Species	8	22300.96	2787.62	1.17	0.3341 NS
Irrigation * Species	4	5795.51	1448.87	0.61	0.6573 NS
Salinity * Irr. * Spec.	8	15064.48	1883.06	0.79	0.6113 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (17): LSD for Total dry weight in 1m^2 (Variable: salinity)

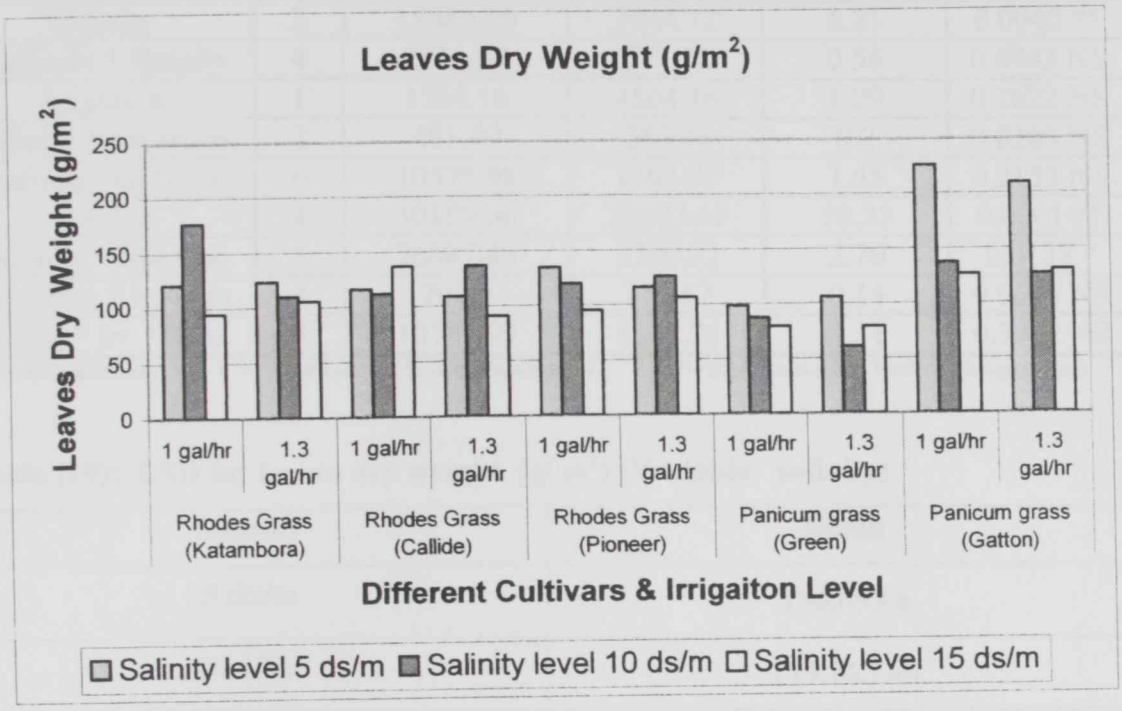
Salinity	Mean
5 dS/m	**331.28 a**
10 dS/m	**263.39 b**
15 dS/m	**252.93 b**

Columns followed by the same letter are non-significant at level 0.05

The LSD for dry weight at 1m^2 shows that there was no difference between salinity 10 dS/m, and salinity 15 dS/m. Plants, however were drastically affected higher at salinity 5 dS/m and the rest of the salinities.

Leaves dry weight (g)/m^2:

Figure (13): Leaves dry weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Separating leaves from stems also gives an indication of the effect of salinity on the plant. As described previously, the leaves were separated when fresh, and then where put in the oven for drying for two days.

Results showed that there were some effects on Rhodes grsss (Katambora, Claide, Pioneer), and Panicum grass (Green, Gatton). For example, Rhodes grass (Katambora) in irrigation 1.3 gal/hr weight 124 g in salinity 5 dS/m, 110.1 g in salinity 10 dS/m, and 105.7 in salinity 15 dS/m. Also Panicum grass (Green) at irrigation 1 gal/hr weight 98.06 g at salinity 5 dS/m, 87.2 g at salinity 10 dS/m, and 79.43 g at salinity 15 dS/m. Panicum grass (Gatton) on the other hand at irrigation 1 gal/hr gained 225.96 g at salinity 1 gal/hr , 137.1 g at salinity 10 dS/m and 126.1 g at salinity 15 dS/m.

Table (18): ANOVA table for the leaves dry weight (g/ m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	119382.86	2911.77	2.4	0.0020
Error	48	58339.68	1215.41		
Corrected Total	89	177722.55			
Replicate	2	553.89	276.94	0.23	0.7971 NS
Salinity	2	15089.45	7544.72	6.21	0.0040 **
Replicate * Salinity	4	2711.89	677.97	0.56	0.6943 NS
Irrigation	1	1564.16	1564.16	1.29	0.2622 NS
Salinity * Irrigation	2	481.89	240.94	0.2	0.8208 NS
Salinity(rep.*irr.)	6	10579.98	1763.33	1.45	0.2153 NS
Species	4	50109.66	12527.41	10.31	0.0001 **
Salinity * Species	8	26807.43	3350.92	2.76	0.0137 *
Irrigation * Species	4	702.5	175.62	0.14	0.9646 NS
Salinity * Irr. * Spec.	8	10784.97	1347.74	1.11	0.3742 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (19): LSD for leaves dry weight (g/ m^2) (Variable: salinity)

Salinity	Mean
5 dS/m	**136.093 a**
10 dS/m	**119.263 ab**
15 dS/m	**104.397 b**

Columns followed by the same letter are non-significant at level 0.05

Table (20): LSD for leaves dry weight (g/ m^2) (Variable: species)

Species	Mean
Panicum (Gatton)	**159.19 a**
Rhodes (Katambora)	**122.16 b**
Rhodes (Callide)	**116.81 b**
Rhodes (Pioneer)	**116.35 b**
Panicum (Green)	**85.08 c**

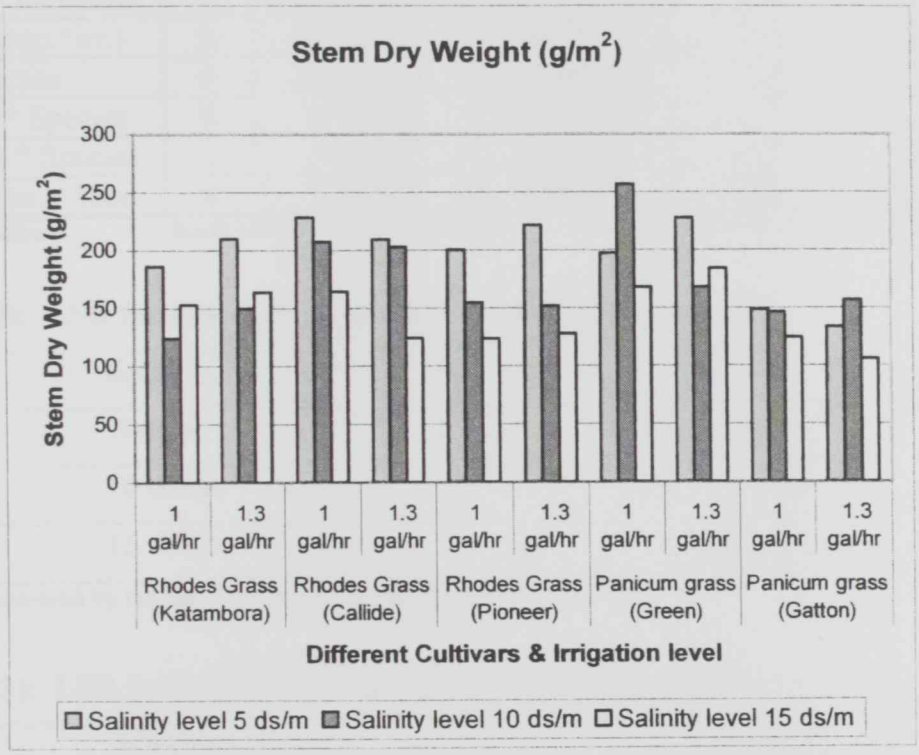
Columns followed by the same letter are non-significant at level 0.05

Statistical analysis for the above, shows that there is a high significant difference between salinity (1) 5 dS/m, and salinity (3) 15 dS/m, but when comparing salinity (1) 5

dS/m and 10 dS/m, the difference was significant, cultivars were also effected. Species no (4) Panicum grass (Green) was highly significant when compared to the other species. Also, the weight of (5) Panicum grass (Gatton) has was significant than the other species. But when comparing species Rhodes grass (Katambora), (Claide), and (Pioneer), they are non-significant.

Stem dry weight (g/m^2):

Figure (14): Stem dry weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Rhodes grass (Katambora), and (Claide) were significantly deferent from one another. For an example, Rhodes grass (Claide) at irrigation 1.3 gal/hr had a stem dry weight of 209.06 (g) and 202.7 (g), and 124.16 (g) at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, stem dry weight of Rhodes grass (Pioneer) was significantly declined with increasing salinity from 5 dS/m, and ending at salinity 15 dS/m.

Panicum grass (Green) however, at irrigation 1, it weight 148.5 g at salinity 1, 146 g at salinity 2, and 124.66 g at salinity 3. This sows that the plant was not affected at 10

dS/m (salinity 2), at higher salinity, stem weight decreased form 146 g to 124.66 g. By comparing species (Rhodes grass and Panicum grass), we found that the salinity had an equal effect.

Table (21): ANOVA table for the stem dry weight (g /m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	165290.93	4031.48	2.38	0.0021
Error	48	81391.94	1695.66		
Corrected Total	89	246682.88			
Replicate	2	381.22	190.61	0.11	0.8939 NS
Salinity	2	41133.08	20566.54	12.13	0.0001 **
Replicate * Salinity	4	11955.57	2988.89	1.76	0.1519 NS
Irrigation	1	228.16	228.16	0.13	0.7154 NS
Salinity * Irrigation	2	1598.82	799.41	0.47	0.6270 NS
Salinity(rep.*irr.)	6	24662.43	4110.4	2.42	0.0397 *
Species	4	45384.71	11346.17	6.69	0.0002 **
Salinity * Species	8	21446.84	2680.85	1.58	0.1556 NS
Irrigation * Species	4	5051.59	1262.89	0.74	0.5663 NS
Salinity * Irr. * Spec.	8	13448.4	1681.05	0.99	0.4547 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (22): LSD for stem dry weight (g /m^2) (Variable: salinity)

Salinity	Mean
5 dS/m	**196.18 a**
10 dS/m	**171.62 b**
15 dS/m	**143.85 c**

Columns followed by the same letter are non-significant at level 0.05

Table (23): LSD for stem dry weight (g /m^2) (Variable: species)

Species	Mean
Panicum (Green)	**200.01 a**
Rhodes (Callide)	**189.34 ab**
Rhodes (Katambora)	**164.41 b**
Rhodes (Pioneer)	**163.21 bc**
Panicum (Gatton)	**135.78 c**

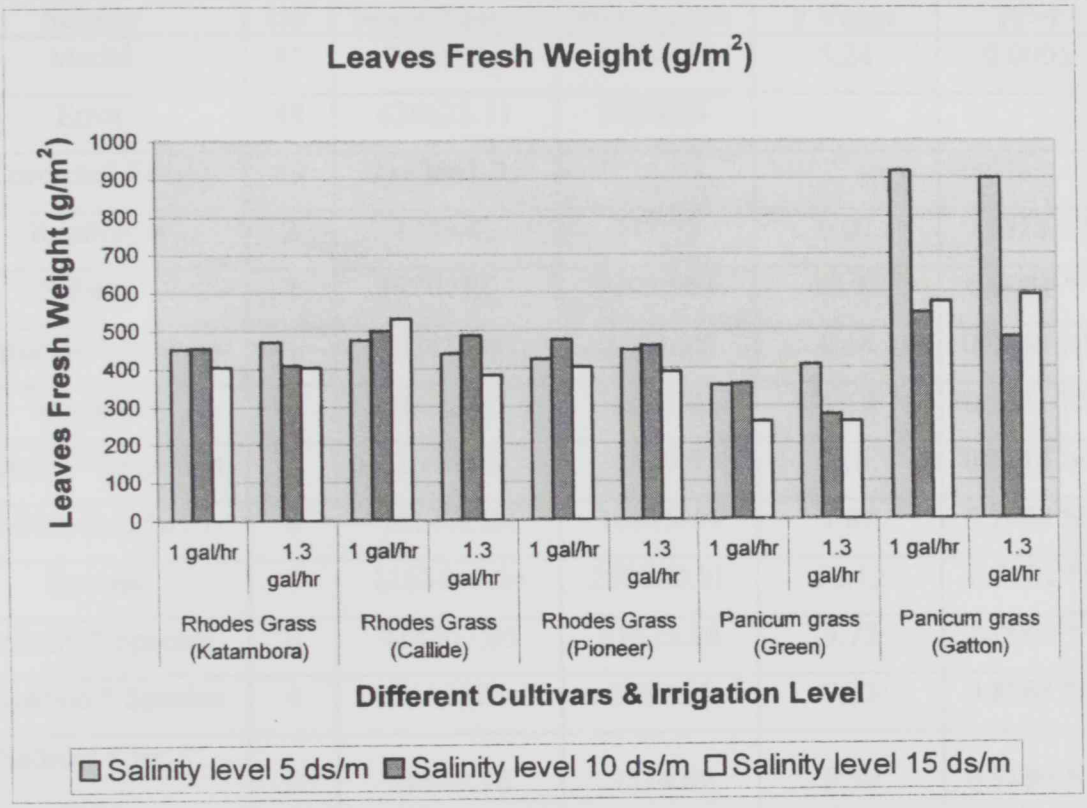
Columns followed by the same letter are non-significant at level 0.05

By comparing the three salinities, we can see that they are highly significant. For example, at salinity (1)5 dS/m the stem dry weight was 196.18 and at salinity (3) 15 dS/m it was with 143.85 g. For example, the difference in stem weight between Panicum

(Green) and Rhodes grass (Claide) was significantly. A similar was found for, Rhodes grass (Katambor), and (Pioneer). When comparing Panicum grass (Green) with Rhodes grass (Katambora) and Panicum grass (Gatton) a high significant difference was also found.

Leaves fresh weight (g/m^2):

Figure (15): Leaves fresh weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results show that fresh leaf weight was significantly affected by salinity. For example, fresh leaf weight of Rhodes grass (Katambora) at irrigation 1 gal/hr weight 453.8 g in salinity 5 dS/m, 456.2 g in salinity 10 dS/m, and 404.8 g at salinity 15 dS/m. Also Rhodes grass (Claide) was not affected by salinity at 1 gal/hr , because fresh leaf weight was 475.23 g at salinity 5 dS/m, 499.64 g at salinity 10 dS/m, and 531.43 g at salinity 15 dS/m.

Panicum grass (Green and Gatton) were affected by salinity. For example, Panicum grass (Gatton) at irrigation 1 gal/hr weight 354.56 (g) at salinity 5 dS/m, 357.7 (g) at salinity 10 dS/m, and decreased to 258.43 (g) at salinity 15 dS/m. Panicum grass (Gatton) was also significantly affected in that leaf weight decreased at irrigation 1 gal/hr form 917.76 (g), 544.73 (g), and 573.6 (g) at salinity 5 dS/m, 10 dS/m, and 3 dS/m.

Table (24): ANOVA table for the Leaves fresh weight (g/ m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1946038.14	47464.34	5.24	0.0001
Error	48	434623.11	9054.64		
Corrected Total	89	2380661.25			
Replicate	2	1295.43	647.71	0.07	0.9311 NS
Salinity	2	197905.03	98952.51	10.93	0.0001 **
Replicate * Salinity	4	5215.88	1303.97	0.14	0.9648 NS
Irrigation	1	10623.25	10623.25	1.17	0.2841 NS
Salinity * Irrigation	2	10900.6	5450.3	0.6	0.5518 NS
Salinity(rep.*irr.)	6	101492.64	16915.44	1.87	0.1058 NS
Species	4	1163440.04	290860.01	32.12	0.0001 **
Salinity * Species	8	414607.05	51825.88	5.72	0.0001 **
Irrigation * Species	4	11959	2989.75	0.33	0.8563 NS
Salinity * Irr. * Spec.	8	28599.16	3574.89	0.39	0.9180 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (25): LSD for leaves fresh weight (g /m^2) (Variable: salinity)

Salinity	Mean
5 dS/m	**529.17 a**
10 dS/m	**444.67 b**
15 dS/m	**419.54 b**

Columns followed by the same letter are non-significant at level 0.05

Table (26): LSD for leaves fresh weight (g /m^2) (Variable: species)

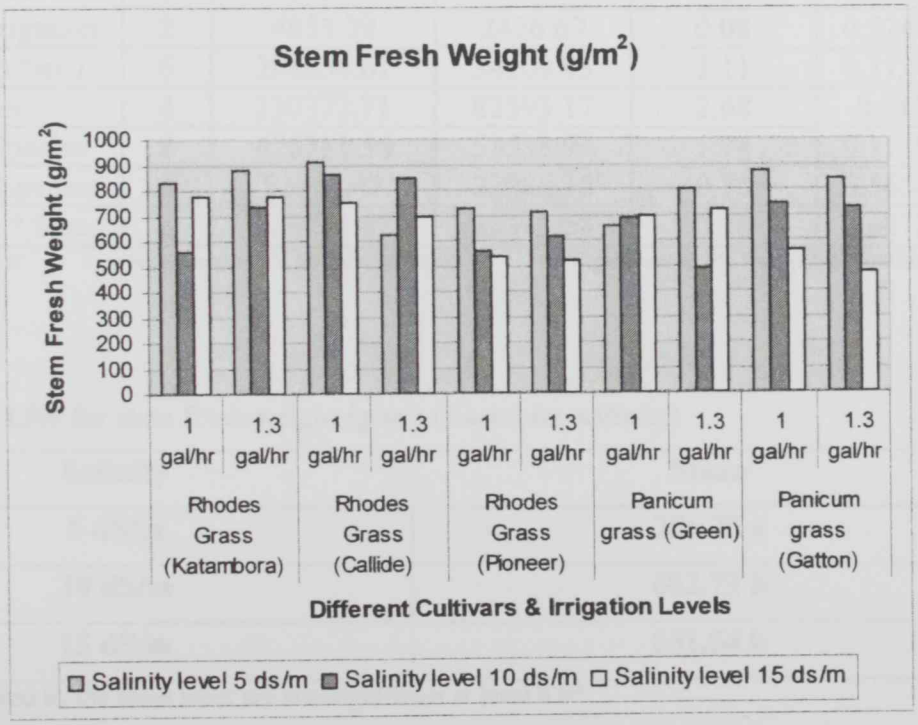
Species	Mean
Panicum (Gatton)	668.04 a
Rhodes (Callide)	469.04 b
Rhodes (Pioneer)	433.27 b
Rhodes (Katambora)	433.14 b
Panicum (Gatton)	318.80 c

Columns followed by the same letter are non-significant at level 0.05

LSD's above, show that (in the salinity section) there is no significant difference between salinity 2 (10 dS/m) and salinity 3 (15 dS/m), however the salinity 1 (5 dS/m) was significantly greater than the others. Statistical analysis also shows that some species were significantly different, which others were not. No difference were found Rhodes grass (Claide), Rhodes grass (Pioneer), and Rhodes grass (Katambora). Panicum grass (Gatton) showed a highly significant difference when compared with Panicum grass (Green).

Stem fresh weight (g/m^2):

Figure (16): Stem fresh weight in 1m^2 (g) of difference cultivars under different salinity levels, and different irrigation level.



Stem fresh weight of Rhodes grass (Katambora) at irrigation 1.3 gal/hr was 876.16 g at salinity 5 dS/m, 737.06 g at salinity 10 dS/m, and 779 g at salinity 15 dS/m. difference were significant, and the difference is coming from salinity 10 dS/m and 15 dS/m. Also Rhodes grass (Claide and Pioneer) were also affected. For an example, Rhodes grass (Claide) at irrigation 1 gal/hr weighed 915.13 g at salinity 5 dS/m, 861.26 g at salinity 10 dS/m, and 750.66 g at salinity 15 dS/m.

Panicum grass on the other hand was not affected by salinity in cultivar's (Green). However in cultivar's (Gatton) there has been some effect. For example, Panicum grass (Gatton) at irrigation 1 gal/hr weighed 875.9 g in salinity 5 dS/m, 742.6 g at salinity 10 dS/m, and 562.23 g at salinity 15 dS/m.

Table (27): ANOVA table for the stem fresh weight (g /m^2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1594471.89	38889.55	1.26	0.2181
Error	48	1479256.01	30817.83		
Corrected Total	89	3073727.9			
Replicate	2	8542.54	4271.27	0.14	0.8709 NS
Salinity	2	300731.25	150365.62	4.88	0.0118 *
Replicate * Salinity	4	31154.62	7788.65	0.25	0.9066 NS
Irrigation	1	7152.05	7152.05	0.23	0.6322 NS
Salinity * Irrigation	2	4853.39	2426.69	0.08	0.9244 NS
Salinity(rep.*irr.)	6	204659.61	34109.93	1.11	0.3724 NS
Species	4	330372.71	82593.17	2.68	0.0426 *
Salinity * Species	8	428311.56	53538.94	1.74	0.1139 NS
Irrigation * Species	4	91945.43	22986.35	0.75	0.5656 NS
Salinity * Irr. * Spec.	8	186748.67	23343.58	0.76	0.6412 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (28): LSD for stem fresh weight (g/m^2) (Variable: salinity)

Salinity	Mean
5 dS/m	**786.75 a**
10 dS/m	**682.73 b**
15 dS/m	**651.54 b**

Columns followed by the same letter are non-significant at level 0.05

Table (29): LSD for stem fresh weight (g/m^2) (Variable: species)

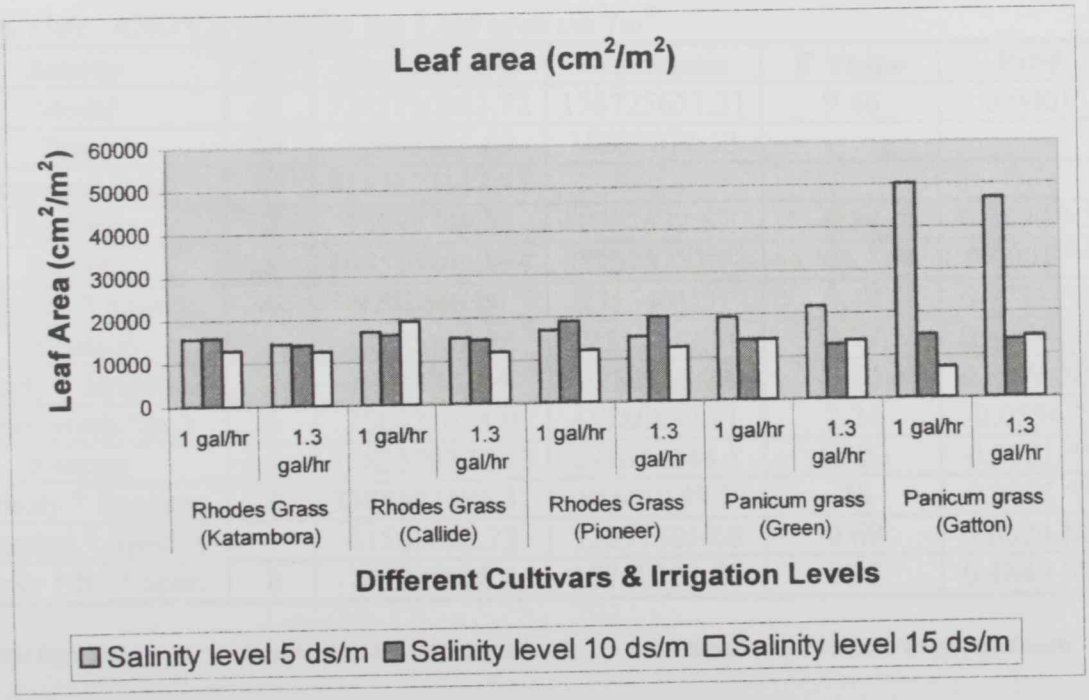
Species	Mean
Rhodes (Callide)	782.41 a
Rhodes (Katambora)	760.25 a
Panicum (Gatton)	704.63 ab
Panicum (Green)	674.32 ab
Rhodes (Pioneer)	613.42 b

Columns followed by the same letter are non-significant at level 0.05

The difference between salinities and the interaction, is significant, and at the same time there is no difference (non-significant) between salinity 2 (10 dS/m) and salinity 3 (15 dS/m). For the difference we found that, the difference between the cultivars is significant, and at the same time it showed no difference between cultivars 2 and 1 (Rhodes Claide and Rhodes Katambora) and cultivars 4 and 5 (Panicum Green and Panicum Gatton).

Leaf area (cm^2/m^2):

Figure (17): Leaf Area in $1m^2$ (cm^2) of difference cultivars under different salinity levels, and different irrigation level.



Leaf area is considered one of the most important indicators of the effect of the salinity on plant. Salinity is known to cause stunted growth and small leaves when compared with healthy plants. Results showed that there were a difference between the species, Rhodes grass (Katambora, Claide, Pioneer), and Panicum grass (Green, Gatton). The most salinity affected cultivar was Panicum cultivars.

For example, Rhodes grass (Katambora) was significantly affected at irrigation 1 gal/hr it when it weighed (15841 cm^2) at salinity 5 dS/m, (15984) cm^2 salinity 10 dS/m, and (13049.9 cm^2) at salinity 15 dS/m. Also leaf area of Rhodes grass (Claide) at irrigation 1.3 gal/hr was 15427.8 cm^2 at salinity 5 dS/m, 49142 cm^2 at salinity 10 dS/m, and 11976 cm^2 at salinity 15 dS/m.

On the other hand, Panicum grass was strongly affected because of salinity. For example, Panicum grass (Green) weighed at irrigation 1 gal/hr 19379.8 cm^2 at salinity 5 dS/m, 14132.8 cm^2 at salinity 10 dS/m, and at 14194.1 cm^2 at salinity 15 dS/m. Also Panicum grass (Gatton) at irrigation 1 gal/hr weighed 50183.73 cm^2 at salinity 5 dS/m, 14332.23 cm^2 at salinity 10 dS/m, and 7192.16 cm^2.

Table (30): ANOVA table for the Leaf area cm^2/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	7245750883.72	176725631.31	9.46	0.0001
Error	48	89662233.69	18680671.53		
Corrected Total	89	8142423117.41			
Replicate	2	19995345.75	9997672.87	0.54	0.5890 NS
Salinity	2	1685151455.44	842575727.72	45.1	0.0001 **
Replicate * Salinity	4	9261846.04	2315461.51	0.12	0.9732 NS
Irrigation	1	14335432.54	14335432.54	0.77	0.8354 NS
Salinity * Irrigation	2	4465961.44	2232980.72	0.12	0.8876 NS
Salinity(rep.*irr.)	6	250721038.9	41786839.81	2.24	0.0554 *
Species	4	1182579776.43	295644944.1	15.83	0.0001 **
Salinity * Species	8	3885593196.31	485699149.53	26	0.0001 **
Irrigation * Species	4	51566022.73	12891505.68	0.69	0.6024 NS
Salinity * Irr. * Spec.	8	142080808.1	17760101.01	0.95	0.4849 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Table (31): LSD for leaf area cm^2/m^2 (Variable: salinity)

Mean	Salinity
23289 a	5 dS/m
15545 b	10 dS/m
13150 c	15 dS/m

Columns followed by the same letter are non-significant at level 0.05

Table (32): LSD for LSD for leaf area cm^2/m^2 (Variable: irrigation)

Mean	Irrigation
17727.2 a	1 gal/hr
16929.0 a	1.3 gal/hr

Columns followed by the same letter are non-significant at level 0.05

Table (33): LSD for LSD for leaf area cm^2/m^2 (Variable: species)

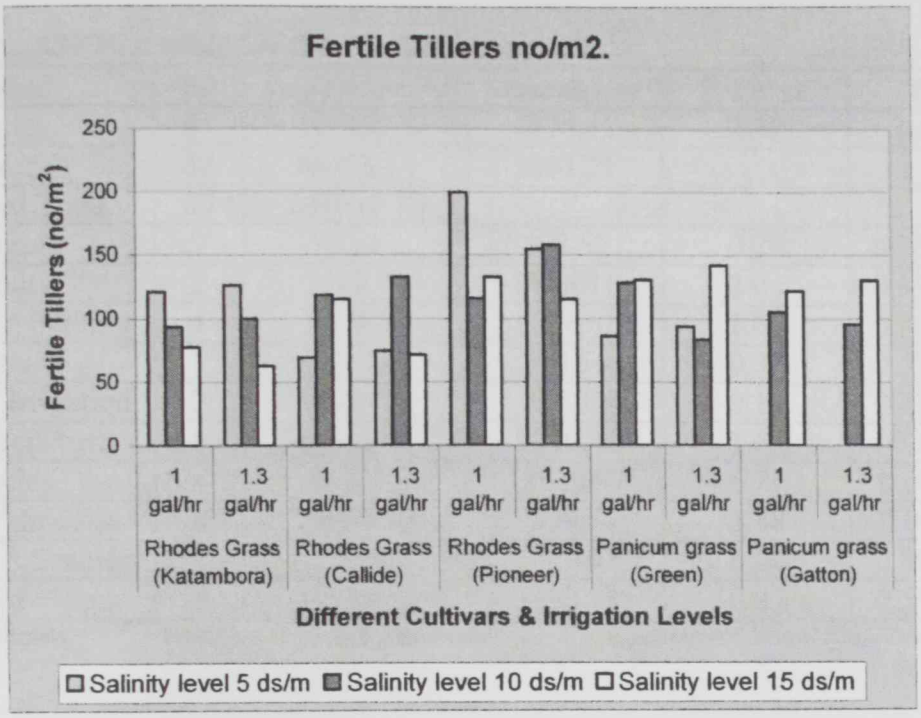
Mean	Species
24475 a	Panicum (Gatton)
15971 b	Panicum (Green)
15952 b	Rhodes (Pioneer)
15875 b	Rhodes (Callide)
14367 b	Rhodes (Katambora)

Columns followed by the same letter are non-significant at level 0.05

The LSD for leaf area shows that the difference between salinities is highly significant. Further, the LSD shows that the difference between the two irrigation levels (1 gal/hr and 1.3 gal/hr) was not significant. In the species section, analysis results shows that the difference between Panicum grass (Gatton) and the rest of the cultivars were highly-significant, and it also shows that there was no difference (non-significant) between the rests of the cultivars.

Fertile tillers no./m^2:

Figure (18): Fertile tillers (no.) of difference cultivars under different salinity levels, and different irrigation level.



Data showed that in some cases plants were affected by salinity, and in other cases it was not affected. Differences are described in the LSD tables. For example, Rhodes grass (Katambora) at irrigation 1 gal/hr was 121.07 no, 94.06 no, and 77.6 no at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. On the other hand, Rhodes grass (Claide) at irrigation 1 gal/hr fertile tillers 68.93 no at, 118.63 no at, and 115.33 no at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. It shows that as salinity increases, the fertile tiller number increases. Also, Rhodes grass (Pioneer) was significantly difference, at irrigation 1.3 gal/hr it when fertile tillers were 154.67 no at , 158.23 no, and 115.1 no at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Panicum grass on the other hand has not been affected by the salinity, and showed that it is salinity tolerant and can produce a number of fertile tillers, even if the salinity is increasing. For example, Panicum grass (Green) at irrigation 2, fertile tillers was 93.86

tillers at salinity 1, 83.7 tillers at salinity 2, and 141.96 no at salinity 3. Also Panicum grass at irrigation 1 had 0 tiller (may be due to some problems in the irrigation system) at salinity1, 95.76 tiller at salinity 2, and 130.03 no at salinity3.

Table (34): ANOVA table for the Fertile tillers no./m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	175252.6	4274.45	2.37	0.0022
Error	48	86458.14	1801.21		
Corrected Total	89	261710.75			
Replicate	2	997.11	498.55	0.28	0.7594 NS
Salinity	2	7412.83	3706.41	2.06	0.1389 NS
Replicate * Salinity	4	7458.44	1864.61	1.04	0.3989 NS
Irrigation	1	574.56	574.56	0.32	0.5748 NS
Salinity * Irrigation	2	650.02	325.12	0.18	0.8355 NS
Salinity(rep.*irr.)	6	18001.44	3000.24	1.67	0.15 NS
Species	4	48923.9	12230.97	6.79	0.0002 **
Salinity * Species	8	79035.93	9879.49	5.48	0.0001 **
Irrigation * Species	4	272.07	68.19	0.04	0.9972 NS
Salinity * Irr. * Spec.	8	11926.26	1490.78	0.83	0.5826 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (35): LSD for LSD for fertile tillers cm^2/m^2 (Variable: species)

Species	Mean
Rhodes (Pioneer)	**146.06 a**
Panicum (Gatton)	**110.81 b**
Rhodes (Katambora)	**97.03 bc**
Rhodes (Callide)	**96.89 bc**
Panicum (Gatton)	**75.52 c**

Columns followed by the same letter are non-significant at level 0.05

The LSD shows that there are highly significant difference between the cultivars, except for species 1 (Rhodes grass: Katambora) and (Rhodes grass: Claide). Although the mean between species 3 (Rhodes grass: Pioneer) and (Panicum grass: Green) shows drastically decreasing in fertile tillers. Also Panicum grass (Gatton) showed highly significant difference when comparing it with other cultivars like (Rhodes grass: Pioneer) or (Panicum grass: Green).

Cut no 3

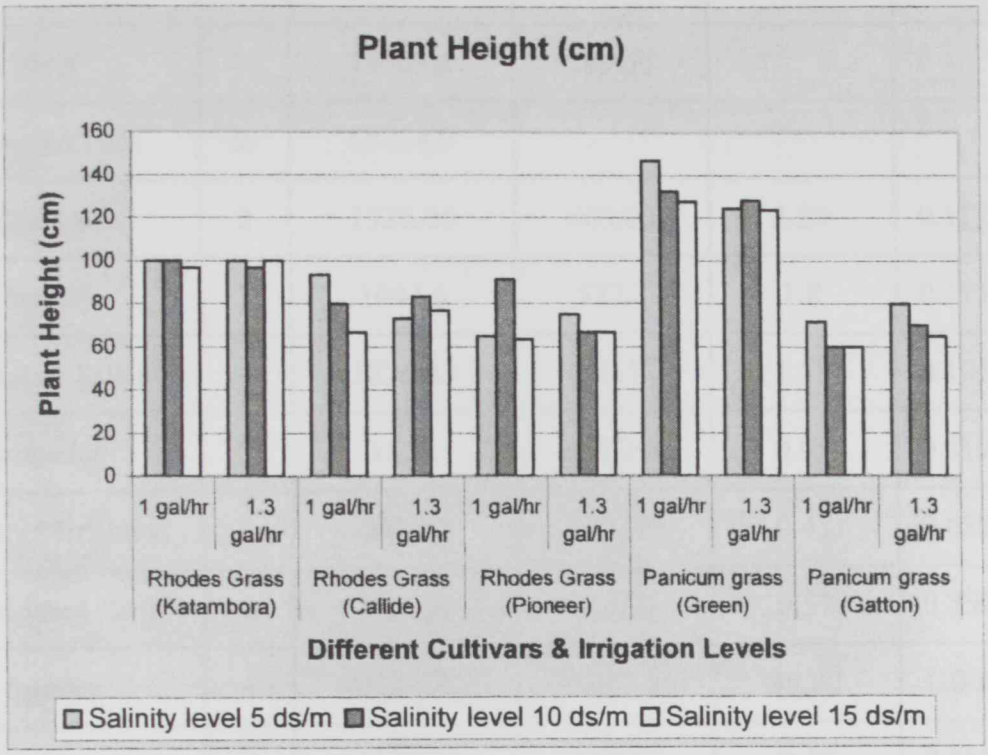
Table (36): Analysis of Variance of Plant Measurements.

Source of variations	F value												
	Degree of Freedom	Plant height	Total tiller no.	Leaf length	Internodes Length	Total fresh weight in $1m^2$	Total dry weight in $1m^2$	Leaves dry weight in $1m^2$	Stem dry weight in $1m^2$	Leaves fresh weight in $1m^2$	Stem fresh weight in $1m^2$	Leaf Area in $1m^2$	Fertile Tillers no.
Model	41	0.0001	0.0231	0.001	0.0384	0.0002	0.0009	0.0008	0.0020	0.0002	0.0007	0.0001	0.0126
Error	48												
Corrected Total	89												
Replicate	2	0.1123 NS	0.9165 NS	0.9986 NS	0.2045 NS	0.8261 NS	0.6709 NS	0.9217 NS	0.9205 NS	0.9621 NS	0.9058 NS	0.7987 NS	0.6700 NS
Salinity	2	0.1758 NS	0.9679 NS	0.0095 **	0.2402 NS	0.0001 **	0.0008 **	0.0377 *	0.0750 *	0.0003 **	0.0004 **	0.0001 **	0.0103 NS
Replicate * Salinity	4	0.1958 NS	0.7928 NS	0.4475 NS	0.4047 NS	0.7322 NS	0.8860 NS	0.8363 NS	0.7694 NS	0.7842 NS	0.6783 NS	0.8548 NS	0.6370 NS
Irrigation	1	0.8197 NS	0.9990 NS	0.6389 NS	0.4203 NS	0.7134 NS	0.8579 NS	0.5210 NS	0.2677 NS	0.4127 NS	0.6000 NS	0.7317 NS	0.2157 NS
Salinity * Irrigation	2	0.6388 NS	0.4898 NS	0.8852 NS	0.7526 NS	0.9934 NS	0.9177 NS	0.9416 NS	0.8373 NS	0.3139 NS	0.5504 NS	0.8990 NS	0.0514 **
Salinity (rep.*irr.)	6	0.7503 NS	0.0281 *	0.5130 NS	0.2256 NS	0.8775 NS	0.6499 NS	0.8722 NS	0.9963 NS	0.5403 NS	0.9680 NS	0.6886 NS	0.3479 NS
Species	4	0.0001 **	0.0005 **	0.0001 **	0.0001 **	0.0126 *	0.0001 **	0.0001 **	0.0001 **	0.0001 **	0.0001 **	0.0001 **	0.0005 **
Salinity * Species	8	0.8655 NS	0.0147 *	0.8357 NS	0.7667 NS	0.0001 **	0.0031 **	0.6868 NS	0.0551 *	0.2148 NS	0.0925 *	0.0070 **	0.0188 *
Irrigation * Species	4	0.7841 NS	0.8160	0.9198 NS	0.8534 NS	0.5736 NS	0.6832 NS	0.3557 NS	0.8392 NS	0.0716	0.3019 NS	0.1780 NS	0.3911 NS
Salinity * Irr.*Spec.	8	0.4717 NS	0.4424	0.9881 NS	0.2475 NS	0.9645 NS	0.6470 NS	0.7378 NS	0.7413 NS	0.2781 NS	0.4136 NS	0.7374 NS	0.3379 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Plant height (cm):

Figure (19): Plant Height (cm) of difference cultivars under different salinity levels, and different irrigation level.



Results from the ANOVA table show that there is no difference between the interactions except for species. Results showed that there was a small effect on the Rhodes grass (Katambora). On the other hand, Rhodes grass (Claide) seems to be affected by salinity especially in irrigation 1 gal/hr , because it plant height was 93.33 cm, 80 cm, and 66.66 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, Rhodes grass (Pioneer) was significantly affected by salinity except for irrigation 1 gal/hr salinity 5 dS/m, which has suddenly increased due to increased in water amount, or in low salinity level.

Panicum grass was significantly affected by the salinity. For example, plant height of Panicum grass at irrigation 1 gal/hr was 146.66 cm, 132.33 cm, and 127.66 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, Panicum grass was significantly reduced in irrigation 1 gal/hr and 1.3 gal/hr .

Table (37): ANOVA table for the Plant height (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	54531.3	1330.03	4.59	0.0001
Error	48	13903.6	289.65		
Corrected Total	89	68434.9			
Replicate	2	1326.06	663.03	2.29	0.1123 NS
Salinity	2	1044.6	522.3	1.8	0.1758 NS
Replicate * Salinity	4	1826.33	456.58	1.58	0.1958 NS
Irrigation	1	15.21	15.21	0.05	0.8197 NS
Salinity * Irrigation	2	262.02	131.01	0.45	0.6388 NS
Salinity(rep.*irr.)	6	994.66	165.77	0.57	0.7503 NS
Species	4	45208.62	11302.15	39.02	0.0001 **
Salinity * Species	8	1108.17	138.52	0.48	0.8655 NS
Irrigation * Species	4	501.73	125.43	0.43	0.7841 NS
Salinity * Irr. * Spec.	8	2243.86	280.48	0.97	0.4717 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (38): LSD for Plant height (cm) (Variable: species)

Species	Mean
Panicum (Green)	**128.333 a**
Rhodes (Katambora)	**98.889 b**
Rhodes (Callide)	**78.889 c**
Rhodes (Pioneer)	**71.278 c**
Panicum (Gatton)	**67.778 c**

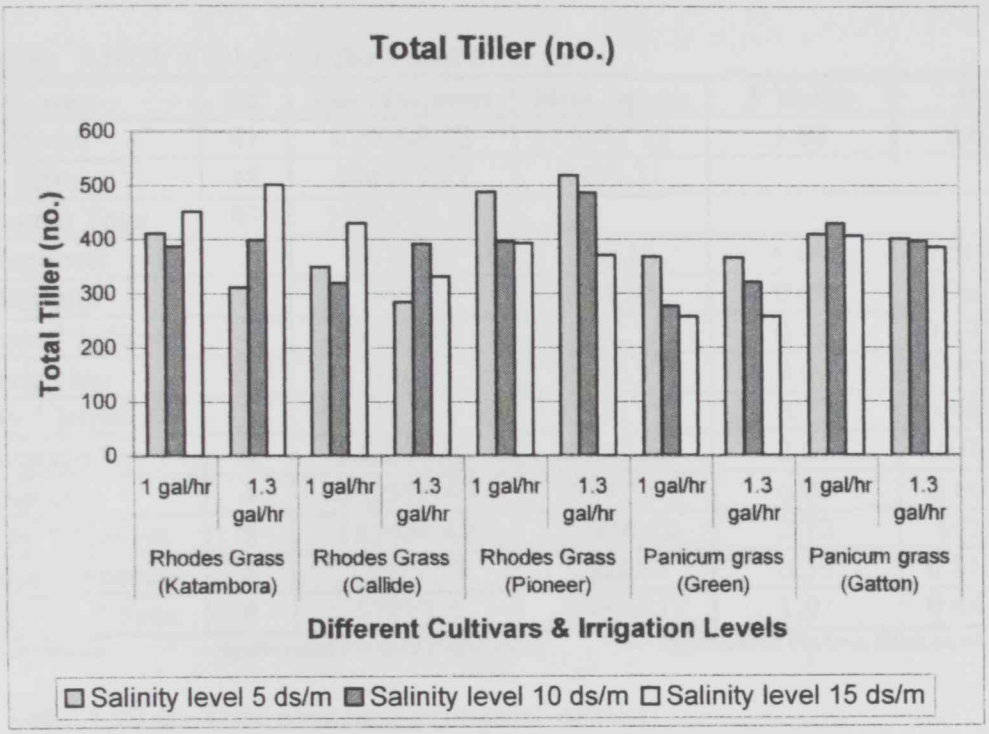
Columns followed by the same letter are non-significant at level 0.05

The difference between Panicum grass species and the rest of the species is highly significant. There is also no difference between species 2, 3, and 5 (Rhdoes grass: Claide,

Rhodes grass: Pioneer and Panicum grass: Gatton). Also species 1 (Rhodes grass: Katambora) was highly significantly difference from all others.

Total Tiller (no.):

Figure (20): Total Tiller (no.) of difference cultivars under different salinity levels, and different irrigation level.



ANOVA table shows that significant difference were related to salinity, and species. Interaction between them was also significant. Effects on cultivars varies with some affected significantly and other were not. For example, tiller no. of Rhodes grass (Katambora) at irrigation 1 gal/hr was 411.16 no, 386.66 no, and 451.66 no at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, at irrigation 1.3 gal/hr the number of the tillers increased, with increasing salinity level. This suggests that plants were salinity tolerant. Rhodes grass (Pioneer) was affected by the salinity in irrigation 1 1 gal/hr and 1.3 gal/hr . For example, at irrigation 1.3 gal/hr tiller number was 518.96 no, 481.1 no, and 370.86 no. at salinity 5 dS/m, 10dS/m, and 15 dS/m, respectively.

Panicum also showed some significant differences due to salinity. For example, total tiller number of Panicum grass (Green) at irrigation 1 gal/hr were 367.76 no, 276.7 no, and 356.76 no at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, total tiller number of Panicum grass (Gatton) at irrigation 1 were 409.7 no, 429.63 no, and 405.76 no at salinity 5, 10, and 15 dS/m respectively. At irrigation 2, salinity also affected tillers with 400.7 no, 395.7 no, and 384.46 no at salinity 5, 10, and 15 dS/m respectively.

Table (39): ANOVA table for the Total tiller (no.)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	629068.32	15343.12	1.82	0.0231
Error	48	404127.27	8419.31		
Corrected Total	89	1033195.59			
Replicate	2	1470.33	735.16	0.09	0.9165 NS
Salinity	2	549.9	274.95	0.03	0.9679 NS
Replicate * Salinity	4	14171.01	3542.75	0.42	0.7928 NS
Irrigation	1	0.013	0.013	0.00	0.9990 NS
Salinity * Irrigation	2	12197.9	6098.95	0.72	0.4898 NS
Salinity(rep.*irr.)	6	132296.02	22049.33	2.62	0.0281 *
Species	4	203911.46	50977.86	6.05	0.0005 **
Salinity * Species	8	183478.68	22934.83	2.72	0.0147 *
Irrigation * Species	4	13075.57	3268.89	0.39	0.8160 NS
Salinity * Irr. * Spec.	8	67917.4	8489.67	1.01	0.4424 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (40): LSD for Total tiller (no.) (Variable: salinity)

Salinity	Mean
5 dS/m	**390.82 a**
10 dS/m	**388.00 a**
15 dS/m	**384.77 a**

Columns followed by the same letter are non-significant at level 0.05

Table (41): LSD for Total tiller (no.) (Variable: species)

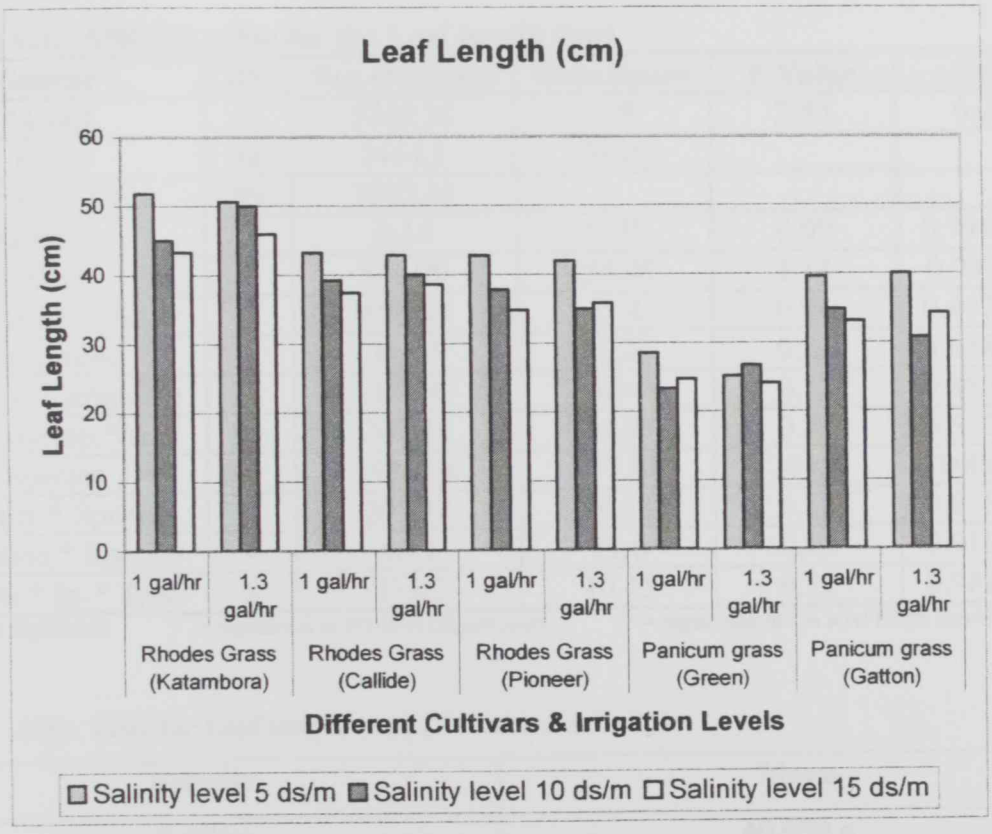
Species	Mean
Rhodes (Pioneer)	**442.08 a**
Rhodes (Katambora)	**426.51 a**
Panicum (Gatton)	**404.28 ab**
Rhodes (Callide)	**351.31 bc**
Panicum (Green)	**315.13 c**

Columns followed by the same letter are non-significant at level 0.05

Results show that there was no difference between salinities, with very small differences in mean. However, the LSD species showed a high-significant difference between the species. For an example, there is a difference between species. For an example, there is a difference between species 5, 2, and 4 (Panicum grass: Gatton, Rhodes grass: Claide, and Panicum grass: Green) respectively. There is no difference between species 3 and 1 (Rhodes grass: Pioneer, Rhodes grass: Katambora).

Leaf length (cm):

Figure (21): Leaf Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Changes in the leaf length were significant due to the effect of salinity and irrigation level. For example, leaf length of Rhodes grass (Katambora) at irrigation 1 gal/hr were 51.83 cm, 45.03 cm, and 43.33 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. At irrigation 1.3 gal/hr , leaf length was changed at salinity 5 dS/m, and

lower at salinity 10 dS/m-15 dS/m. Rhodes grass (Claide) was also affected by the salinity in both irrigation 1 gal/hr and 1.3 gal/hr . For example, at irrigation 1 gal/hr leaf length was 43.26 cm, 39.2 cm, and 37.4 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Although, Panicum grass was affected by salinity, example, leaf length of Panicum grass (Green) at irrigation 1 was 28.5 cm, 23.33 cm, and 24.73 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Results also showed that Panicum grass (Gatton) was affected by salinity. For example, at irrigation 1 gal/hr , leaf length was 39.6 cm, 34.76 cm, and 33.03 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Table (42): ANOVA table for the Leaf length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	5248.31	128	2.55	0.001
Error	48	2414.1	50.29		
Corrected Total	89	7662.41			
Replicate	2	0.14	0.07	0.00	0.9986 NS
Salinity	2	516.99	258.49	5.14	0.0095 **
Replicate * Salinity	4	189.63	47.4	0.94	0.4475 NS
Irrigation	1	11.23	11.23	0.22	0.6389 NS
Salinity * Irrigation	2	12.29	6.14	0.12	0.8852 NS
Salinity(rep.*irr.)	6	267.18	44.53	0.89	0.5130 NS
Species	4	3911.66	977.91	19.44	0.0001 **
Salinity * Species	8	209.13	26.14	0.52	0.8357 NS
Irrigation * Species	4	46.4	11.6	0.23	0.9198 NS
Salinity * Irr. * Spec.	8	83.62	10.45	0.21	0.9881 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (43): LSD for Leaf length (cm) (Variable: salinity)

Salinity	Mean
5 dS/m	**40.650 a**
10 dS/m	**37.160 ab**
15 dS/m	**34.817 b**

Columns followed by the same letter are non-significant at level 0.05

Table (44): LSD for Leaf length (cm) (Variable: species)

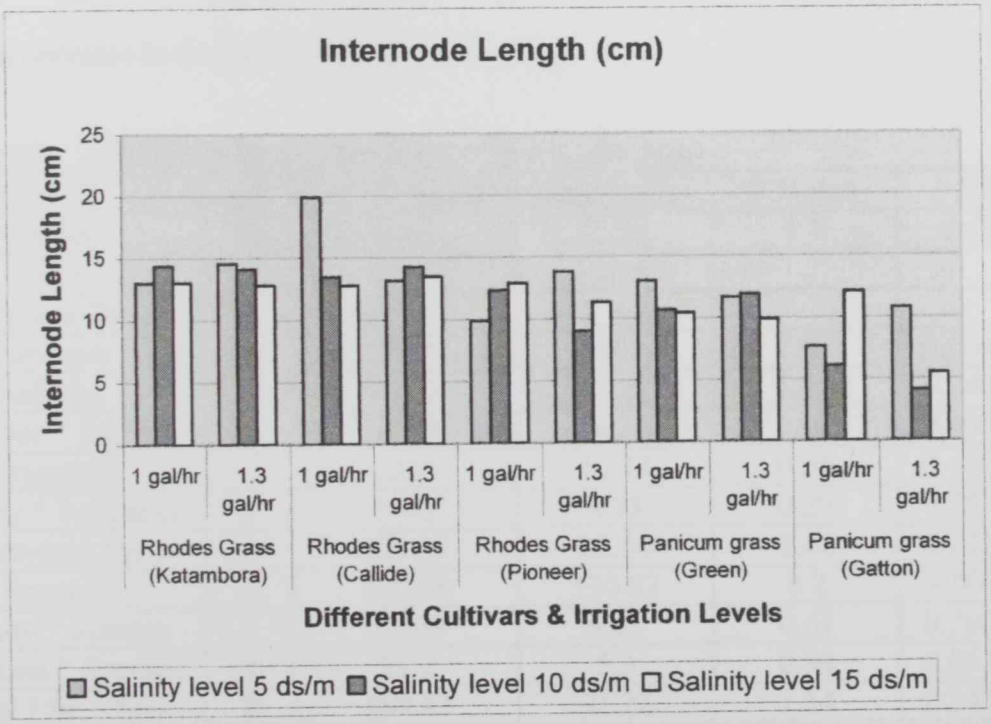
Species	Mean
Rhodes (Katambora)	**47.161 a**
Rhodes (Callide)	**40.206 b**
Rhodes (Pioneer)	**38.022 bc**
Panicum (Gatton)	**35.406 c**
Panicum (Green)	**26.917 d**

Columns followed by the same letter are non-significant at level 0.05

Differences related to Salinity shows highly significant between the three different. For example, the leaf length in salinity 1 (5 dS/m) was 40.650, 37.160 at salinity 2 (10 dS/m), and 34.817 at salinity 3 (15 dS/m). Species were highly significant as well.

Internodes length (cm):

Figure (22): Internodes Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Internodes length of Rhodes grass (Katambora) was significantly affected. At irrigation 1 gal/hr the crop internodes length was 13.03 cm, 14.4 cm, and 13.03 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. There increase was an increase in internode length between salinity 5 dS/m and 10 dS/m due to tolerance of salinity. However, at irrigation 1.3 gal/hr it internodes length decreased from 14.56 cm, 14.1 cm at, and 12.33 cm at salinity. Also Rhodes grass (Claide) has changed drastically in irrigation 1 gal/hr , and 1.3 gal/hr . For example, internodes length was 19.93 cm, 13.46 cm, and 12.8 at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Also, at irrigation 1 gal/hr it was 9.83 at, 12.36, and 12.9 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass (Green) was significantly affected by treatments. At irrigation 1 gal/hr internodes length was 13.03 cm, 10.7 cm, and 10.43 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. On the other hand Panicum grass gained 7.63 cm at, 6.1 cm, and 12.06 at salinities 5 dS/m, 10 dS/m, and 15 dS/m respectively. The plant started with a decrease in length, and this drastic effect might be due to water stress, or might be due to a decrease in the salinity in this section only.

Table (45): ANOVA table for the Internodes length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1106.46	26.98	1.7	0.0384
Error	48	760.72	15.84		
Corrected Total	89	1867.18			
Replicate	2	52.01	26	1.64	0.2045 NS
Salinity	2	46.57	23.28	1.47	0.2402 NS
Replicate * Salinity	4	64.89	16.22	1.02	0.4047 NS
Irrigation	1	10.47	10.47	0.66	0.4203 NS
Salinity * Irrigation	2	9.06	4.53	0.29	0.7526 NS
Salinity(rep.*irr.)	6	135.27	22.54	1.42	0.2256 NS
Species	4	520.08	130.02	8.2	0.0001 **
Salinity * Species	8	77.06	9.63	0.61	0.7667 NS
Irrigation * Species	4	21.2	5.3	0.33	0.8534 NS
Salinity * Irr. * Spec.	8	169.82	21.22	1.34	0.2475 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (46): LSD for Internodes length (cm) (Variable: species)

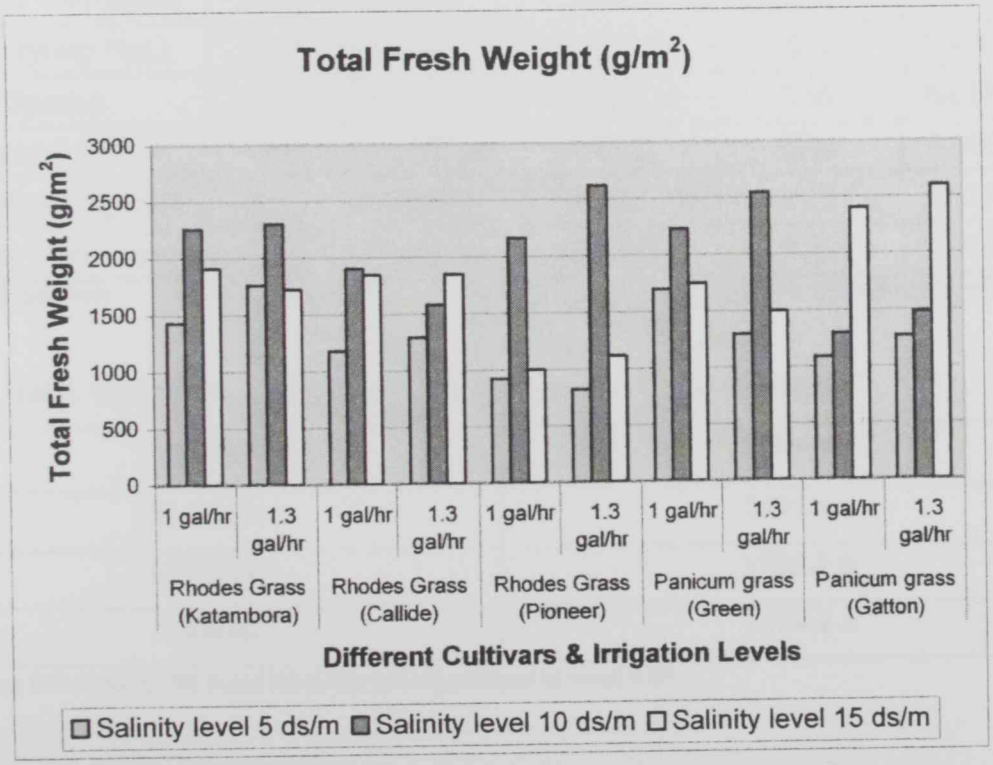
Species	Mean
Rhodes (Callide)	**14.528 a**
Rhodes (Katambora)	**13.839 ab**
Rhodes (Pioneer)	**11.550 b**
Panicum (Green)	**11.261 b**
Panicum (Gatton)	**7.683 c**

Columns followed by the same letter are non-significant at level 0.05

When comparing the means of the species together from the above table, it is noted that species difference has highly significant. Two species however were not-significantly (Rhodes grass: Pioneer and Panicum grass: Green). Also Rhodes grass (Claide) and Rhodes grass (Katambora) showed significant difference between them when compared to Panicum grass (Gatton).

Total fresh weight (g/m^2):

Figure (23): Total Fresh Weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that all species and their cultivars were affected by salinity. This effect might be due to the fact that plants becomes more tolerant to salinity as it grows bigger in size. For example, Rhodes grass (Katambora) at irrigation 1 gal/hr were 1432 g, 2261.33 g, and 1909.33 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Also, total fresh weight of Rhodes grass (Claide) at irrigation 1.3 gal/hr was 1293.33 g, 1578.66, and 1846.53 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Panicm grass (Gatton) also was affected with irrigation 1.3 gal/hr 1265.33 g 1, 1479 g at, and 2601.86 g at salinity 5dS/m, 10 dS/m, and 15 dS/m

Table (47): ANOVA table for the Total fresh weight (g) /m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	26933885.8	656924.04	2.92	0.0002
Error	48	10801702.29	225035.46		
Corrected Total	89	37735588.09			
Replicate	2	86336.96	43168.48	0.19	0.8261 NS
Salinity	2	10019384.76	5009692.38	22.26	0.0001 **
Replicate * Salinity	4	454615.92	113653.98	0.51	0.7322 NS
Irrigation	1	30728.54	30728.54	0.14	0.7134 NS
Salinity * Irrigation	2	2994.15	1497.07	0.01	0.9934 NS
Salinity(rep.*irr.)	6	535558.97	89259.82	0.4	0.8775 NS
Species	4	3209175.29	802293.82	3.57	0.0126 NS
Salinity * Species	8	11405057.22	1425632.15	6.34	0.0001 **
Irrigation * Species	4	660254.96	165063.74	0.73	0.5736 NS
Salinity * Irr. * Spec.	8	529778.99	66222.37	0.29	0.9645 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (48): LSD for Total fresh weight in $1m^2$ (g) (Variable: salinity)

Salinity	Mean
10 dS/m	**2079.2 a**
15 dS/m	**1799.1 b**
5 dS/m	**1274.2 c**

Columns followed by the same letter are non-significant at level 0.05

Table (49): LSD for Total fresh weight in $1m^2$ (g) (Variable: species)

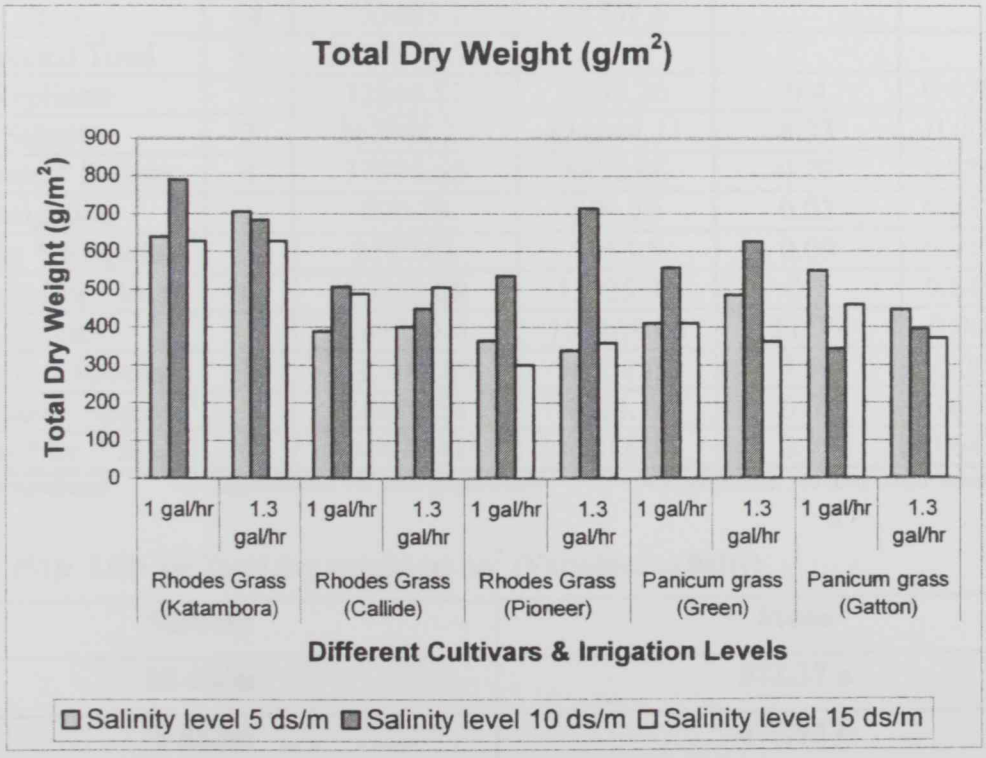
Species	Mean
Rhodes (Katambora)	**1948.3 a**
Panicum (Green)	**1903.8 ab**
Panicum (Gatton)	**1677.5 ab**
Rhodes (Callide)	**1607.6 bc**
Rhodes (Pioneer)	**1438.3 c**

Columns followed by the same letter are non-significant at level 0.05

The LSD, results shows that two species was not significant different, Rhodes grass (Katambora) was different from the rest of the species, and that Rhodes grass (Pioneer) is highly significant when compared with other species in the table.

Total dry weight (g)/m^2:

Figure (24): Total Dry Weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



results showed that Rhodes grass in general was not affected by salinity. Crop dry weight increased while salinity increases. For example, Rhodes grass (Katambora) in irrigation 1 gal/hr total dry weight was 640 g, 790.66 g in and 627.26 g in salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, dry weight Rhodes grass increase in irrigation 1.3 gal/hr when it gained 400 g, 447.13 g at, and 505.33 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Panicum grass (Green) increased in weight especially in salinity 10 dS/m irrigation 1 gal/hr and irrigation 1.3 gal/hr . At irrigation 1 gal/hr , gained 410.66 g at, 566.66 g at, and 410.66 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Also Panicm grass (gatton) in irrigation 1.3 gal/hr showed decreasing in the dry weight as a result of the effect of salinity, where it gained 446.66 g at, 393.86 g at, and 370.73 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Table (50): ANOVA table for the Total dry weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1672474.42	40792.05	2.59	0.0009
Error	48	755405.1	15737.6		
Corrected Total	89	2427879.52			
Replicate	2	12666.52	6333.26	0.4	0.6709 NS
Salinity	2	262088.23	131044.11	8.33	0.0008 **
Replicate * Salinity	4	17970.65	4492.66	0.29	0.8860 NS
Irrigation	1	509.79	509.79	0.03	0.8579 NS
Salinity * Irrigation	2	2707.01	1353.5	0.09	0.9177 NS
Salinity(rep.*irr.)	6	66215.68	11035.94	0.7	0.6499 NS
Species	4	741879.4	185469.85	11.79	0.0001 **
Salinity * Species	8	437848.09	54731.01	3.48	0.0031**
Irrigation * Species	4	36096.58	9024.14	0.57	0.6832 NS
Salinity * Irr. * Spec.	8	94492.42	11811.55	0.75	0.6470 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (51): LSD for Total dry weight (g) /m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**572.37 a**
5 dS/m	**472.93 b**
15 dS/m	**447.23 b**

Columns followed by the same letter are non-significant at level 0.05

Table (52): LSD for Total dry weight (g)/m^2 (Variable: species)

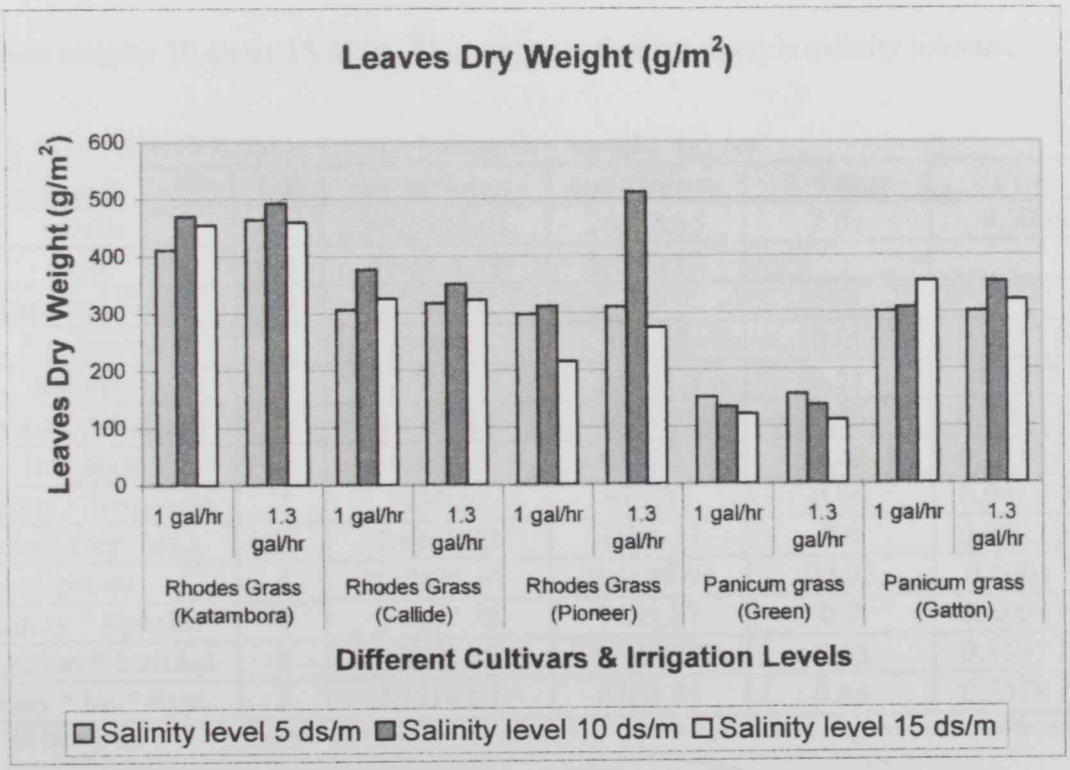
Species	Mean
Rhodes (Katambora)	**672.81 a**
Panicum (Green)	**495.78 b**
Rhodes (Callide)	**456.22 b**
Rhodes (Pioneer)	**435.28 b**
Panicum (Gatton)	**427.48 b**

Columns followed by the same letter are non-significant at level 0.05

Results showed that there was no difference between salinity 1 (5 dS/m) and at salinity 3 (15 dS/m). When comparing total dry weight of salinity 2 (10 dS/m) with the rest of the treatment salinities, significant differences were found. Differences in species dry weight were significant as well between the species 1 (Rhdoes grass: Katambora) and the rest of the species. Difference between Panicum grass: Green, Rhodes grass: Claide, Rhodes grass: Pioneer, and Panicum grass: Gatton were not significant.

Leaves dry weight (g/m^2):

Figure (25): Leaves dry weight in 1m^2 (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that in some cultivars there was an increase in dry leaf weight with increasing salinity. This indicates that the plant is salinity tolerant, and is capable of growing under such conditions. For example, Rhodes grass (Katambora) at irrigation 1 gal/hr was 411.43 g at, 470.23 g, and 454.03 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Also, dry leaf weight of Rhodes grass (Claide) at irrigation 1.3 gal/hr was 317.93, 351.36 g, and 324.23 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. It shows that dry leaf weight was affected between salinity 5 dS/m and 10 dS/m, but it has decreased drastically between salinity 5 dS/m and 15 dS/m. This suggests that plants are more tolerant to salinity at 5 dS/m-10 dS/m.

Dry leaf weight of Panicum grass was affected when treated by the saline water. For example, dry leaf weight of Panicum grass (Green) at irrigation 1 gal/hr was 151.63 g, 134.76 g, and 121.83 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. While Panicum grass (Gatton) was affected by salinity level. It weight was 301.2 g at, 307.63 g, and 353.66 g, salinity 5dS/m, 10 dS/m, and 15 dS/m respectively. However it shows that there was almost no change between salinity 5 dS/m-10 dS/m, but it increased drastically between salinity 10 dS/m-15 dS/m. This suggests that the plant is salinity tolerant.

Table (53): ANOVA table for the leaves dry weight (g) /m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1092992.61	26658.35	2.61	0.0008
Error	48	490085.38	10210.11		
Corrected Total	89	1583078			
Replicate	2	1668.16	834.08	0.08	0.9217 NS
Salinity	2	71726.4	35863.2	3.51	0.0377 *
Replicate * Salinity	4	14675.81	3668.95	0.36	0.8363 NS
Irrigation	1	4268.35	4268.35	0.42	0.5210 NS
Salinity * Irrigation	2	1230.62	615.31	0.06	0.9416 NS
Salinity(rep.*irr.)	6	24801.22	4133.53	0.4	0.8722 NS
Species	4	818675.67	204668.91	20.05	0.0001 **
Salinity * Species	8	57467.78	7183.47	0.7	0.6868 NS
Irrigation * Species	4	45963.89	11490.97	1.13	0.3557 NS
Salinity * Irr. * Spec.	8	52514.67	6564.33	0.64	0.7378 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (54): LSD for leaves dry weight (g)/m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	358.62 a
5 dS/m	302.03 b
15 dS/m	295.92 b

Columns followed by the same letter are non-significant at level 0.05

Table (55): LSD for Total leaves dry weight (g)/m^2 (Variable: species)

Species	Mean
Rhodes (Katambora)	458.67 a
Rhodes (Callide)	333.69 b
Panicum (Gatton)	322.91 b
Rhodes (Pioneer)	320.45 b
Panicum (Green)	158.56 c

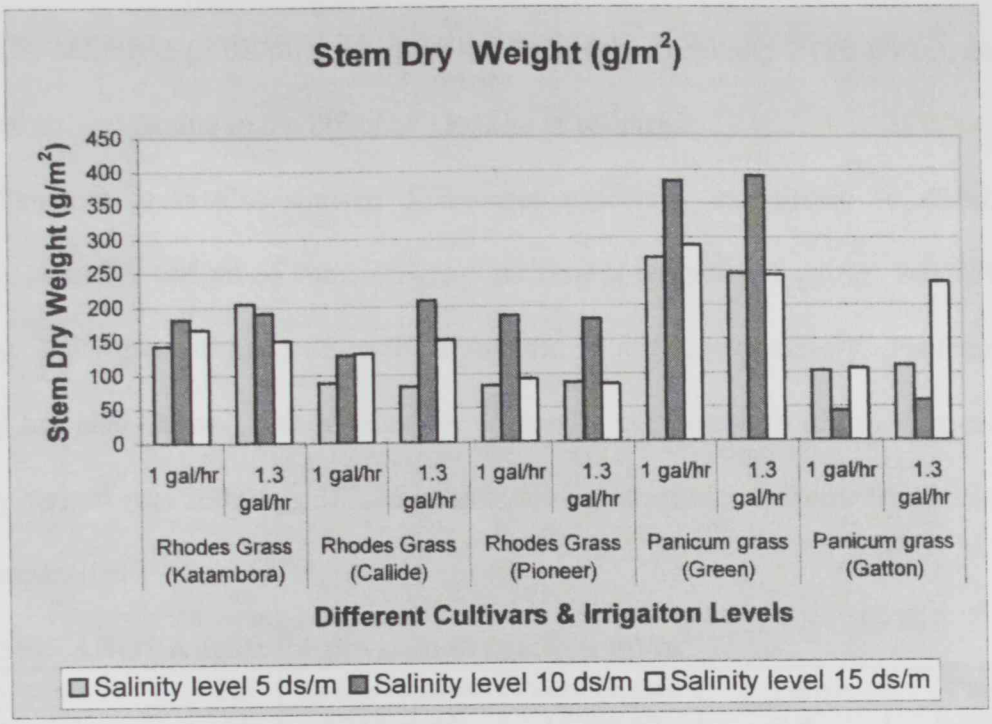
Columns followed by the same letter are non-significant at level 0.05

There are no difference between salinity 1 (5 dS/m) and salinity 3 (15 dS/m). Similarity between the two species might be due to an excess in salt content in the water in salinity 2 (10 dS/m). Logically there should be a difference between salinity 1 (5 dS/m), and the other of the salinities, or at least to be similar to salinity 2 (10 dS/m). The difference between salinity 2 (10 dS/m) and the rest of the salinities was significant.

There is no difference between the species 2, 5, and 3 (Rhodes grass: Claide, Panicum grass: Gatton, and Rhodes grass: Pioneer). However, the difference between species 1 (Rhodes grass: Katambora) and the rest of the species are highly significant, and was the difference for species 4 (Panicum grass: Green).

Stem dry weight (g)/m^2:

Figure (26): Stem dry weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that there are significant changes in some cases. Also, some treatment was not affected by the salinity, because of their tolerance, and the ability to grow under these conditions.

For example, Rhodes grass (Katambora) at irrigation 1 gal/hr a stem dry weight was 142.86 g, increased to 182.3 g, and decreases to 167.43 at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. This means that it was not affected at salinity 5 dS/m-10 dS/m, but when salinity increased from 10 dS/m to 15 dS/m, stem dry weight reduced. Comparing irrigation 1 gal/hr and 1.3 gal/hr , it showed that dry weight decreased starting from salinity 5 dS/m to salinity 15 dS/m. This is due to the amount of water in irrigation 1 gal/hr which is less than the amount of water in irrigation 1.3 gal/hr . However, results also showed that Rhodes grass (Claide) was not affected by salinity, but that stem dry weight increased as well. For example, at irrigation 1 gal/hr it was 88.47 g,

129.83 g, and 132.26 at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Results also showed that Rhodes grass (Pioneer) was affected by salinity especially in salinity 10 dS/m. For example, it stem dry weight was 83 g, 186.4 g, and 92.86 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. This effect might be due that the plant was not affected by salinity 1 (5 dS/m), and increased its weight in salinity 2 (10 dS/m), and then decreased its weight due to the effect of 15 dS/m at salinity 3.

Panicum grass also showed differences especially in salinity 10 dS/m. For example, stem dry weight of Panicum grass (Green) at irrigation 1 gal/hr was 269.96 g, 383.76 g, 288.7 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Panicum grass (Gatton) has also showed drastic changes, especially at salinity 10 dS/m. For example, stem dry weight was 269.96 g, 383.76 g, and 288.7 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Table (56): ANOVA table for the stem dry weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	623596.49	15209.67	2.4	0.0020
Error	48	304811.96	6350.24		
Corrected Total	89	928408.46			
Replicate	2	915.74	457.87	0.07	0.9305 NS
Salinity	2	34739.73	17369.86	2.74	0.0750 *
Replicate * Salinity	4	11518.96	2879.74	0.45	0.7694 NS
Irrigation	1	7984.39	7984.39	1.26	0.2677 NS
Salinity * Irrigation	2	2263.78	1131.89	0.18	0.8373 NS
Salinity(rep.*irr.)	6	3705.41	617.56	0.10	0.9963 NS
Species	4	414751.9	103687.97	16.33	0.0001 **
Salinity * Species	8	106249.79	13281.22	2.09	0.0551 NS
Irrigation * Species	4	9019.93	2254.98	0.36	0.8392 NS
Salinity * Irr. * Spec.	8	32446.84	4055.85	0.64	0.7413 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (57): LSD for stem dry weight (g) /m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**190.07 a**
15 dS/m	**164.99 ab**
5 dS/m	**141.96 b**

Columns followed by the same letter are non-significant at level 0.05

Table (58): LSD for stem dry weight (g) /m^2 (Variable: species)

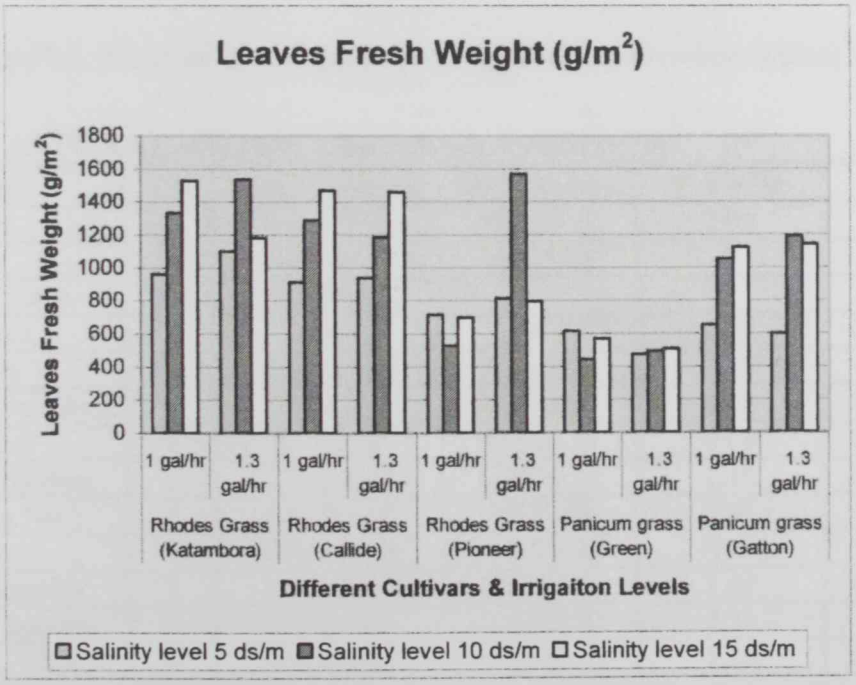
Species	Mean
Panicum (Green)	294.42 a
Rhodes (Katambora)	172.83 b
Rhodes (Callide)	132.28 bc
Rhodes (Pioneer)	119.19 c
Panicum (Gatton)	109.63 c

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis confirmed that there was a significant difference between the three different salinities. Species as well, showed significant differences for some treatment. For example, there was no difference between species 3 and 5 (Rhodes grass: Pioneer and Panicum grass: Gatton respectively). Also, it was shown that there was a difference (significant) between species 1 and 2 (Rhodes grass: Katambora, Rhodes grass: Claide) and highly significant between species 4 (Panicum grass: Green) and the rest of the species.

Leaves fresh weight (g)/m^2:

Figure (27): Leaves fresh weight in 1m^2 (g) of difference cultivars under different salinity levels, and different irrigation level.



Rhodes grass (Katambora) showed some difference in the weight of the fresh leaves. For an example, at irrigation 1 gal/hr the fresh leaf weight was 962.53 g, 133.23 g, and 1528.8 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. The difference is because the plant is salinity tolerant, and also because the amount of salt in the soil is less than irrigation 1.3 gal/hr . Rhodes grass (Claide) showed that it is not affected by salinity, because at irrigation 1 gal/hr it was 912.43 g, 1287.4 g at, and 1470.23 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Pioneer) showed some changes in the fresh leafs weight (decreasing) at irrigation 1 gal/hr when it was 715.5 g at salinity 5 dS/m, 530.16 g at irrigation 1.3 gal/hr , and 697.26 g at salinity 15 dS/m.

Panicum grass showed some differences in fresh leafs weight as well. For example, Panicum grass (Green) decreased in weight in irrigation 1 gal/hr , and increased weight irrigation 1.3 gal/hr . This might be due to the amount of water consumed by the plant, which was greater at 10 dS/m than salinity 5 dS/m. Panicum grass (Gatton), however showed some difference by increasing weight with increased salinity. For example, at irrigation 1 gal/hr fresh leaf weight was 651.5 g, 1052 g, and 1123.36 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. By comparing the 2 irrigation levels (1 gal/hr-1.3 gal/hr), it is clear that irrigation level significantly (increased) plant leaf weight.

Table (59): ANOVA table for the Leaves fresh weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	11420932.45	278559.32	2.99	0.0002
Error	48	4469951.42	93123.98		
Corrected Total	89	15890883.87			
Replicate	2	7198.49	3599.24	0.04	0.9621 NS
Salinity	2	1825236.43	912618.21	9.80	0.0003 **
Replicate * Salinity	4	161240.17	40310.04	0.43	0.7842 NS
Irrigation	1	63595.30	63595.30	0.68	0.4127 NS
Salinity * Irrigation	2	221118.44	110559.22	1.19	0.3139 NS
Salinity(rep.*irr.)	6	473275.61	78879.26	0.85	0.5403 NS
Species	4	5805344.29	1451336.07	15.58	0.0001 **
Salinity * Species	8	1053938.07	131742.25	1.41	0.2148 NS
Irrigation * Species	4	859198.91	214799.72	2.31	0.0716 *
Salinity * Irr. * Spec.	8	950786.68	118848.33	1.28	0.2781 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (60): LSD for leaves fresh weight (g) /m^2 (Variable: salinity)

Salinity	Mean
15 dS/m	1101.16 a
10 dS/m	1055.79 a
5 dS/m	778.95 b

Columns followed by the same letter are non-significant at level 0.05

Table (61): LSD for leaves fresh weight (g) /m2 (Variable: species)

Species	Mean
Rhodes (Katambora)	1288.3 a
Rhodes (Callide)	1209.5 a
Panicum (Gatton)	959.7 b
Rhodes (Pioneer)	853.9 b
Panicum (Green)	581.9 c

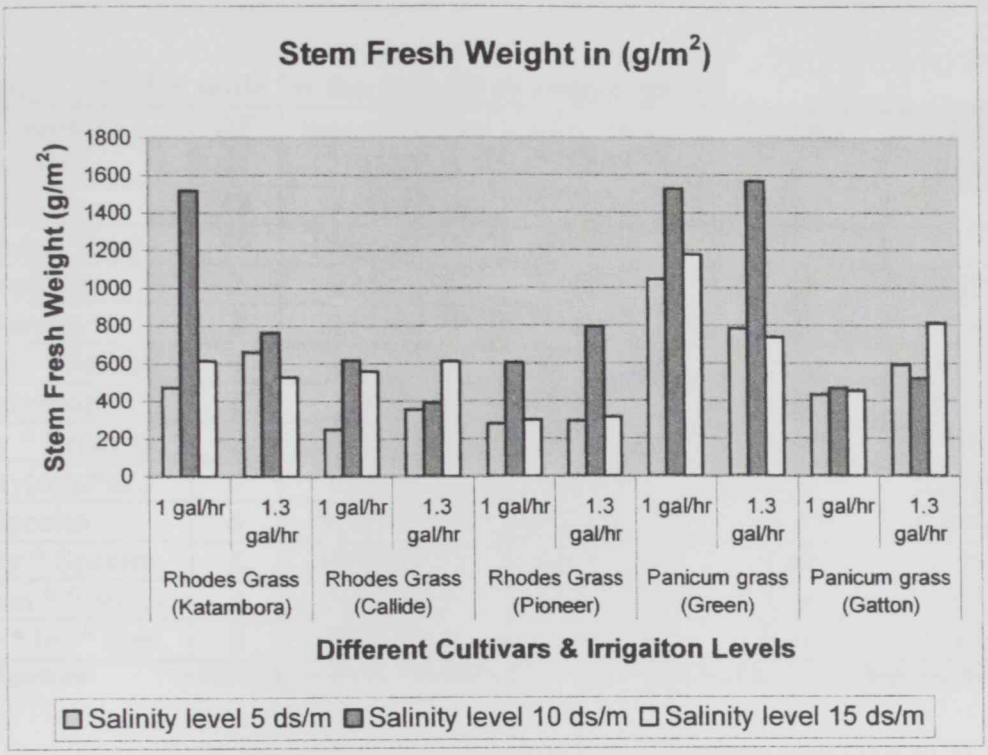
Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was no difference between salinity 2 and 3 (10 dS/m- 15 dS/m), but that salinity 1 (5 dS/m) was significant different. It seems to have some problem with salinity, which might the cause of being less productive than the other higher salinities.

Species effect was variable. For example, there was no difference (non-significant) between species 1 and 2 (Rhodes grass: Katambora, and Rhodes grass: Claide), and also between species 3 and 5 (Rhodes grass: Pioneer, and Panicum grass: Gatton). On the other hand, Panicum grass (Green) were significant different when compared to other species.

Stem fresh weight (g/m^2):

Figure (28): Stem fresh weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Rhodes grass (Katambora) was significantly affected by salinity. At irrigation 1 it was 471.7 g at salinity 1 but then increased to 1516.97 g at salinity 2. This might be due to excessive water, and 614.7 g at salinity 3. On the other hand, stem fresh weight of Rhodes grass (Claide) was 250.1 g at salinity 1, and 615.83 at salinity 2, and 559.56 at salinity 3. Rhodes grass (Pioneer) was significantly affected by salinity. For example, stem fresh weight at irrigation 1, was 280.5 g at salinity1, 606.13 g at salinity 2, and 299.96 g at salinity 3. The big difference in the weight of Rhodes grass (Pioneer) between salinity 1-2 is due to the reasons mentioned previously about the water, salinity, stage of growth.

Panicum grass showed some change in stem fresh weight because of salinity. For example, Panicum grass (Green) at irrigation 1 was 1046.2 g at salinity 1, 1528.73 at salinity 2, and 1177.33 g at salinity 3. Panicum grass (Gatton) has showed significant

change in irrigation 1. For example, stem fresh weight at irrigation 1 it was 432.96 at salinity 1, 466.73 g at salinity 2, and 452.73 g at salinity 3. This difference is due to the tolerance of the plant to the salinity, although the change was small.

Table (62): ANOVA table for the stem fresh weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	12203803.63	297653.74	2.62	0.0007
Error	48	5445923.83	113456.74		
Corrected Total	89	17649727.46			
Replicate	2	22502.01	11251	0.10	0.9058 NS
Salinity	2	2114719.28	1057359.64	9.32	0.0004 **
Replicate * Salinity	4	263387.94	65846.98	0.58	0.6783 NS
Irrigation	1	31625.62	31625.62	0.28	0.60 NS
Salinity * Irrigation	2	137199.26	68599.63	0.6	0.5504 NS
Salinity(rep.*irr.)	6	150634.23	25105.7	0.22	0.9680 NS
Species	4	6292727.44	1573181.86	13.87	0.0001 **
Salinity * Species	8	1670257.15	208782.14	1.84	0.0925*
Irrigation * Species	4	568173.07	142043.26	1.25	0.3019 NS
Salinity * Irr. * Spec.	8	952577.59	119072.19	1.05	0.4136 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (63): LSD for stem fresh weight (g) /m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**879.78 a**
15 dS/m	**617.12 b**
5 dS/m	**516.09 b**

Columns followed by the same letter are non-significant at level 0.05

Table (64): LSD for stem fresh weight (g) /m^2 (Variable: species)

Species	Mean
Panicum (Green)	**1144.3 a**
Panicum (Katambora)	**769.6 b**
Panicum (Gatton)	**545.6 bc**
Rhodes (Callide)	**463.5 c**
Rhodes (Pioneer)	**432.0 c**

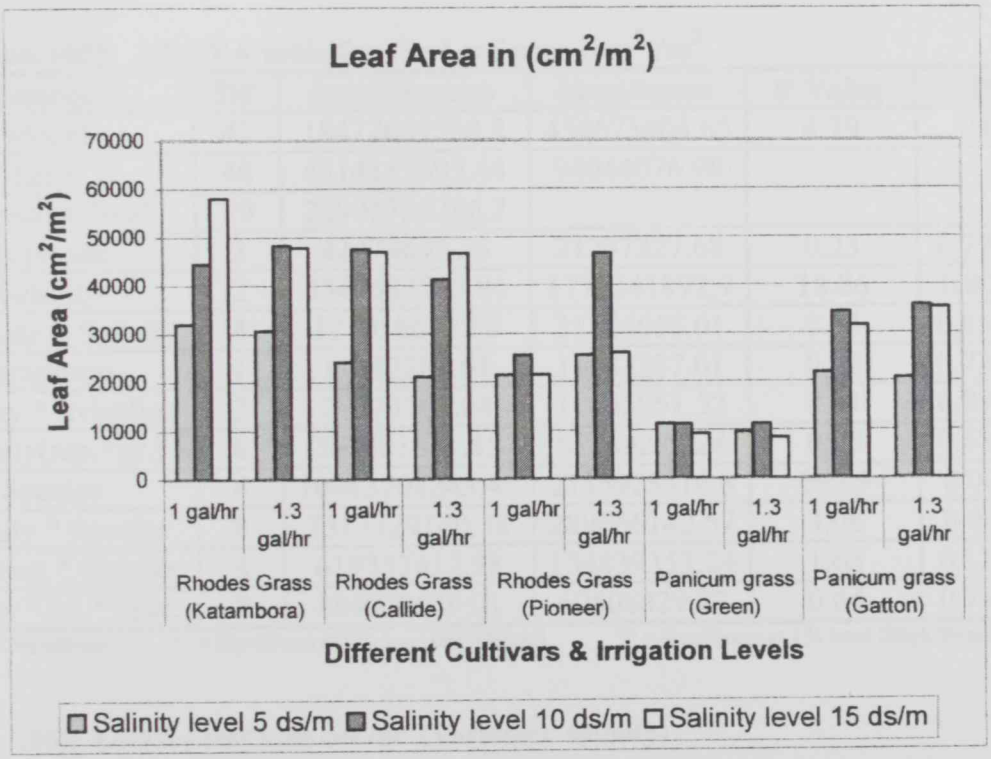
Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was no difference between salinity 3 (15 dS/m) and salinity 1 (5 dS/m), while the difference between salinity 2 (10 dS/m) and the rest of the salinities were highly significant.

Although species showed some differences, some were significant while others were not. For example, there was no change between species 2 and 3 (Rhodes grass: Claide, Rhodes grass: Pioneer). For species 4 and 1 (Panicum grass: Green, Rhodes grass: Katambora) the difference was significant. Also, species 1, 5 (Rhodes grass: Katambora, Rhodes grass: Claide) were significantly different.

Leaf area (cm^2):

Figure (29): Leaf Area in $1m^2$ (cm^2) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that some cultivars were significantly, affected by salinity, either in increasing or decreasing response. For example, Rhodes grass (Katambora) at irrigation 1.3 gal/hr was 30732 cm^2, 48317.5 cm^2, to 47819.6 cm^2 at salinities of 5 dS/m, 10 dS/m, and 15 dS/m, respectively. This demonstrates that plant was salinity tolerant and

not affected by salinity. Also, Rhodes grass (Claide) leaf area increase drastically with an increase in salinity. At irrigation 1 gal/hr it was 24172.37 cm^2, 47493.43 cm^2, and 46921.13 cm^2 at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass also showed some difference as well in irrigation 1 when leaf area was 21450 cm^2 at salinity 1, to 25481 cm^2, 21468 cm^2. This shows that the plant did not being effected by the salinity.

Panicum grass (Green) at irrigation 1 was affected by salinity when leaf area was 11352.67 cm^2 at salinity 1, 11200 cm^2 at salinity 2, and 9156.16 cm^2 at salinity 3. Leaf area of Panicum grass (Gatton) showed drastic increasing change irrigation 1 and 2. For example, at irrigation 2 it was 20733.47 at salinity 1, 35687.8 cm^2 at salinity 2, and 35289.47 cm^2 at salinity 3.

Table no. (65): ANOVA table for the Leaf area (cm^2)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	18477609590.8	450673404.65	4.79	0.0001
Error	48	4514115695.44	94044076.98		
Corrected Total	89	22991725286.2			
Replicate	2	42474655.36	21237327.68	0.23	0.7987 NS
Salinity	2	3546683785.84	1773341892.9	18.86	0.0001 **
Replicate * Salinity	4	125058672.06	31264668.01	0.33	0.8548 NS
Irrigation	1	11182287.01	11182287.01	0.12	0.7317 NS
Salinity * Irrigation	2	20070103.04	10035051.52	0.11	0.8990 NS
Salinity(rep.*irr.)	6	367681651.45	61280275.24	0.65	0.6886 NS
Species	4	10943701243.43	2735925310.8	29.09	0.0001 **
Salinity * Species	8	2317329140.58	289666142.57	3.08	0.0070 **
Irrigation * Species	4	619357412.98	154839353.24	1.65	0.1780 NS
Salinity * Irr. * Spec.	8	484070639.01	60508829.87	0.64	0.7374 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (66): LSD for leaf area cm^2/m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**35992 a**
15 dS/m	**34177 a**
5 dS/m	**21861 b**

Columns followed by the same letter are non-significant at level 0.05

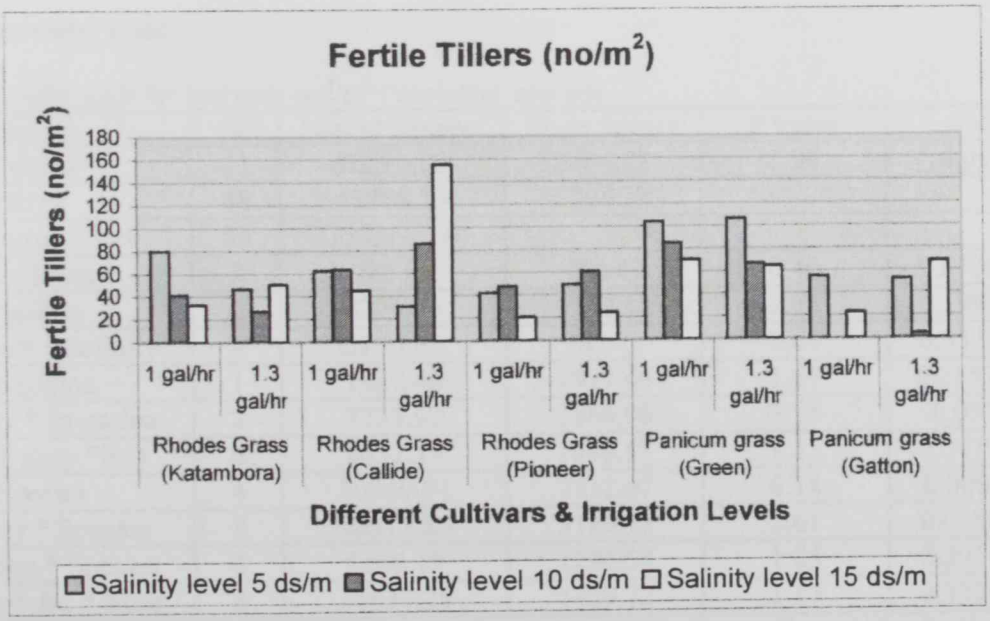
Table (67): LSD for leaf area cm^2/m^2 (Variable: species)

Species	Mean
Rhodes (Katambora)	**45312 a**
Rhodes (Callide)	**37941 b**
Panicum (Gatton)	**29923 c**
Rhodes (Pioneer)	**27751 c**
Panicum (Green)	**12459 d**

Columns followed by the same letter are non-significant at level 0.05

Results showed that, there is no significant difference between salinity 2 (10 dS/m) and salinity 3 (15 dS/m). The difference between salinity 1 (5 dS/m) and the rest of the salinities, on the other hand, was highly significant. The species also showed a significant, and non significant between the different species. For example, the difference between species 1, 2, and 4 (Rhodes grass: Katambora, Rhodes grass: Claide, and Panicum grass: Green), was highly significant between them and the rest of the species. On the other hand, species 5 and 3 (Panicum grass: Gatton, and Rhodes grass: Pioneer) was not significantly from one another, but were highly significant with the rest of the species.

Fertile tillers (no.): Figure (30): Fertile Tillers in $1m^2$ (no.) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that there are cultivars with significant change and there are cultivars with drastic change, either by increasing or decreasing. For example, tiller number at irrigation 1 gal/hr , it was 80.1, 41.56, and 32.73 at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Also, Rhodes grass (Claide) at irrigation 1.3 gal/hr had 30.86 no, 85.73, and 155.1 at salinity 5, 10, and 15 dS/m, respectively. This increase shows that the plant is capable of producing large numbers of fertile tillers, even if salinity increases. This indicates that cultivars are salinity tolerant. Rhodes grass (Pioneer) in irrigation 1 gal/hr was 41.9, 47.53, and 20.36 salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass (Green) showed a decrease in the number of the fertile tillers at both irrigation 1 gal/hr and 1.3 gal/hr . For example at irrigation 1.3 gal/hr tiller number was 105.93, 67.03, and 64.43 at salinities of 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Tiller number of Panicum grass (Gatton) was drastically reduced in both irrigation 1 gal/hr and 1.3 gal/hr at salinity 10 dS/m mainly due to problems with the irrigation systems. Problems such as less water, and blocking of the irrigation nozzle by accumulation of salt were observed. When comparing salinity 5 dS/m and 15 dS/m in irrigation 1 gal/hr , we saw that the difference was not like that seem of salinity 10 dS/m, which drastically decrease in the number of fertile tillers. At irrigation 1.3 gal/hr there was a significant increase in the number of fertile tillers, because of the amount of irrigation water used.

Table no. (68): LSD for leaf area cm^2/m^2 (Variable: species)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	98596.02	2404.78	1.96	0.0126
Error	48	58768.13	1224.33		
Corrected Total	89	157364.16			
Replicate	2	988.99	494.49	0.40	0.6700 NS
Salinity	2	4205.76	2102.88	1.72	0.1903 NS
Replicate * Salinity	4	3130.93	782.73	0.64	0.6370 NS
Irrigation	1	1927.46	1927.46	1.57	0.2157 NS
Salinity * Irrigation	2	7733.92	3866.96	3.16	0.0514 *
Salinity(rep.*irr.)	6	8457.19	1409.53	1.15	0.3479 NS
Species	4	30049.91	7512.47	6.14	0.0005 **
Salinity * Species	8	25517.85	3189.73	2.61	0.0188 NS
Irrigation * Species	4	5146.19	1286.54	1.05	0.3911 NS
Salinity * Irr. * Spec.	8	11437.78	1429.72	1.17	0.3379 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (69): LSD for fertile tillers no./m^2 (Variable: salinity)

Salinity	Mean
5 dS/m	62.853 a
15 dS/m	54.933 a
10 dS/m	46.117 a

Columns followed by the same letter are non-significant at level 0.05

Table (70): LSD for fertile tillers no./m^2 (Variable: irrigation)

Irrigation	Mean
1.3 gal/hr	59.262 a
1 gal/hr	50.007 a

Columns followed by the same letter are non-significant at level 0.05

Table (71): LSD for fertile tillers no./m^2 (Variable: species)

Species	Mean
Panicum (Green)	79.06 a
Rhodes (Callide)	73.81 a
Rhodes (Katambora)	45.75 b
Rhodes (Pioneer)	40.73 b
Panicum (Gatton)	33.83 b

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis and the LSD for the variable data above show that there was no difference between salinity levels. For example, the irrigation levels (1 gal/hr and 1.3 gal/hr) show no difference between them. Also, species like 4 and 2 (Panicum grass: Green and Rhodes grass: Claide) shows no difference between them. However, species like 1, 3, and 5 (Rhodes grass: Katambora, Rhodes grass: Pioneer, and Panicum grass: Gatton) shows no difference in tiller number. But when comparing the two groups together, the difference between them, they are highly significant.

Cut no 4

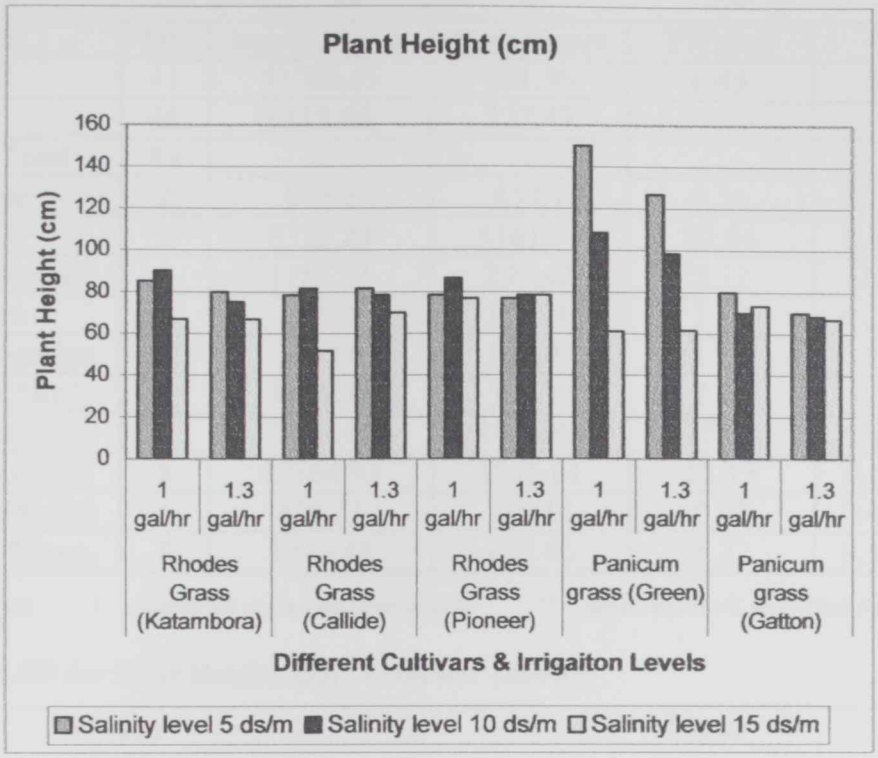
Table (72): Analysis of Variance of Plant Measurements.

Source of variations	F value												
	Degree of Freedom	Plant height	Total tiller no.	Leaf length	Internodes Length	Total fresh weight in $1m^2$	Total dry weight in $1m^2$	Leaves dry weight in $1m^2$	Stem dry weight in $1m^2$	Leaves fresh weight in $1m^2$	Stem fresh weight in $1m^2$	Leaf Area in $1m^2$	Fertile Tillers no.
Model	41	0.0001	0.0003	0.0362	0.0008	0.0049	0.0001	0.0051	0.0001	0.0549	0.0001	0.0074	0.0020
Error	48												
Corrected Total	89												
Replicate	2	0.7109 NS	0.6636 NS	0.4313 NS	0.2464 NS	0.9180 NS	0.7086 NS	0.9088 NS	0.9894 NS	0.9723 NS	0.9819 NS	0.8523 NS	0.0724 NS
Salinity	2	0.0001 **	0.4333 NS	0.5210 NS	0.0002 **	0.0039 **	0.0001 **	0.6926 NS	0.0001 **	0.4238 NS	0.0001 **	0.0056 **	0.9878 NS
Replicate * Salinity	4	0.0705 *	0.9984 NS	0.4976 NS	0.0394 *	0.9966 NS	0.9558 NS	0.9720 NS	0.9463 NS	0.8725 NS	0.9682 NS	0.9847 NS	0.7870 NS
Irrigation	1	0.2801 NS	0.7757 NS	0.5193 NS	0.0047 **	0.7714 NS	0.6118 NS	0.4131 NS	0.9572 NS	0.9773 NS	0.7282 NS	0.9103 NS	0.1743 NS
Salinity * Irrigation	2	0.2269 NS	0.5717 NS	0.1573 NS	0.0809 *	0.9379 NS	0.3874 NS	0.7011 NS	0.7142 NS	0.6264 NS	0.3109 NS	0.4017 NS	0.7798 NS
Salinity (rep.*irr.)	6	0.0425 *	0.6856 NS	0.2934 NS	0.7673 NS	0.8983 NS	0.0214 *	0.0028 **	0.1318 NS	0.8668 NS	0.1618 NS	0.6542 NS	0.5467 NS
Species	4	0.0001 **	0.1674 NS	0.0001 **	0.0081 **	0.2951 NS	0.0001 **	0.0017 **	0.0001 **	0.0003 **	0.0009 **	0.0001 **	0.0001 **
Salinity * Species	8	0.0001 **	0.0001 **	0.1527 NS	0.1137 NS	0.0001 **	0.0001 **	0.0003 **	0.0001 **	0.0022 **	0.0001 **	0.0600 *	0.0008 **
Irrigation * Species	4	0.4520 NS	0.7613 NS	0.4253 NS	0.0233 NS	0.8374 NS	0.8528 NS	0.6439 NS	0.4504 NS	0.9235 NS	0.8368 NS	0.8008 NS	0.1137 NS
Salinity * Irr.*Spec.	8	0.3099 NS	0.8976 NS	0.6866 NS	0.1533 NS	0.7073 NS	0.5204 NS	0.9149 NS	0.3311 NS	0.9024 NS	0.5737	0.9511 NS	0.5443 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Plant height (cm):

Figure (31): Plant Height (cm) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that plant height was affected significantly. For example, plant height of Rhodes grass (Katambora) at irrigation 1 gal/hr was 85 cm, 90 cm, and 66.66 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. These numbers demonstrates that the effect of salinity was small. Also at irrigation 1.3 gal/hr , the height decreased because of salinity. Rhodes grass (Claide) at irrigation 1.3 gal/hr was 81.66 cm, 78.33 cm, and 70 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Differences were significant, but small.

Panicum grass, showed some changes as well in the plant height. Results showed that plant height was reduced in Panicum grass (Green). At irrigation 1 gal/hr plant height was 150 cm at, 108.33 cm, and 61 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m,

respectively. However, Panicum grass (Gatton) at irrigation 1.3 gal/hr was 70 cm, 68.33 cm, and 66.66 cm at salinities 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Table (73): ANOVA table for the Plant height (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	33700.45	821.96	6.45	0.0001
Error	48	6118.66	127.47		
Corrected Total	89				
Replicate	2	87.62	43.81	0.34	0.7109 NS
Salinity	2	8322.28	4161.14	32.64	0.0001 **
Replicate * Salinity	4	1181.71	295.42	2.32	0.0705 *
Irrigation	1	152.10	152.10	1.19	0.2801 NS
Salinity * Irrigation	2	390.06	195.03	1.53	0.2269 NS
Salinity(rep.*irr.)	6	1825.33	304.22	2.39	0.0425 *
Species	4	7659.40	1914.85	15.02	0.0001 **
Salinity * Species	8	12364.93	1545.61	12.13	0.0001 **
Irrigation * Species	4	476.51	119.12	0.93	0.4520 NS
Salinity * Irr. * Spec.	8	1240.48	155.06	1.22	0.3099 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (74): LSD for Plant Height (cm) (Variable: salinity)

Salinity	Mean
5 dS/m	90.667 a
10 dS/m	81.300 b
15 dS/m	67.267 c

Columns followed by the same letter are non-significant at level 0.05

Table (75): LSD for Plant Height (cm) (Variable: irrigation)

Irrigation	Mean
1 gal/hr	81.044 a
1.3 gal/hr	78.444 a

Columns followed by the same letter are non-significant at level 0.05

Table (76): LSD for Plant Height (cm) (Variable: species)

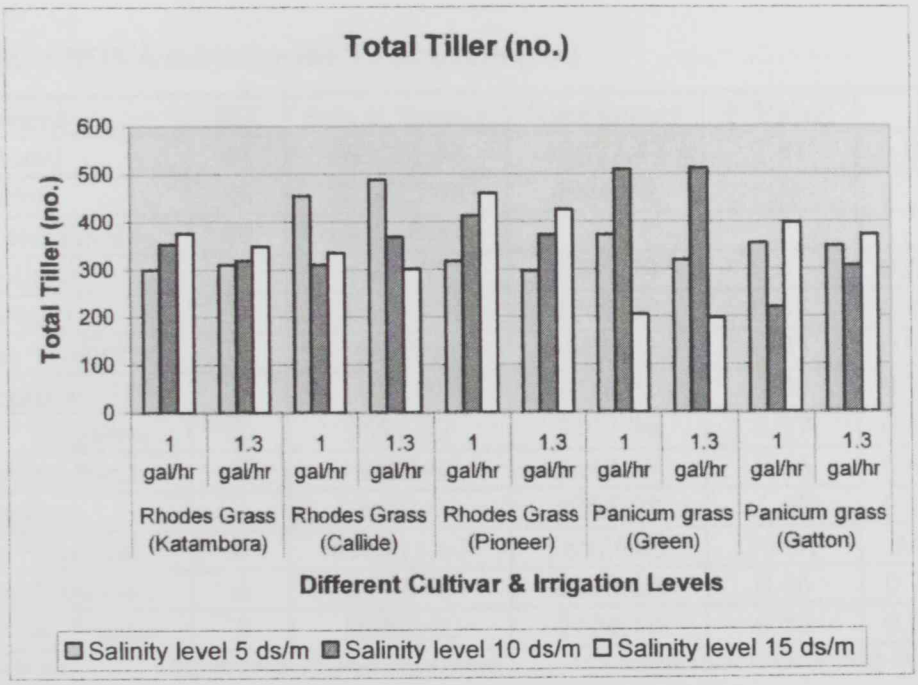
Species	Mean
Panicum (Green)	97.389 a
Rhodes (Pioneer)	79.111 b
Rhodes (Katambora)	77.222 bc
Rhodes (Callide)	73.611 bc
Panicum (Gatton)	71.389 c

Columns followed by the same letter are non-significant at level 0.05

Results showed that there was no significant difference between salinities 1, 2, and 3 (5 dS/m, 10dS/m, and 15 dS/m). While, irrigation levels 1 and 2 (1 gal/hr and 1.3 gal/hr) also did not show any significant difference. For species, it was shown th significant difference. For example, species 1 and 2 (Rhodes grass: Katambora and Rhodes grass: Claide) showed no difference between them, while species 4, 3, and 5 (Panicum grass: Green, Rhodes grass: Pioneer, and Panicum grass: Gatton) was significant different for one another.

Total tiller (no.):

Figure (32): Total Tiller (no.) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that there were some changes (increasing and decreasing) in number of tiller for all species cultivars. For example, total tiller number of Rhodes grass (Katambora) at irrigation 1 was 299.43, 352.67, and 357.57 at salinities 5, 10, 15 dS/m. Also Rhodes grass (Claide) had significantly lower number of tiller at irrigation 2 (1.3

gal/hr) was 487.17, 367.33, and 301 at salinities 5, 10, and 15 dS/m. Also Rhodes grass (Pioneer) showed significant increase in both irrigations 1 and 2. Results showed that the number of total tillers produced at each salinity was more in irrigation 1 than 2. This might be due to the amount of salt which is less in irrigation than the amount in irrigation 2.

Panicum grass on the other hand, showed some inconsistency in the number of total tillers between the three salinities. For example, Panicum grass (Green) at irrigation 2 was 318.67, increased to 511.23, and 196.5 at salinities 5, 10, and 15 dS/m, respectively. Similar observation was observed at Panicum grass (Gatton) at irrigation 1 and 2. For example, total tiller number at irrigation 1 was 354.23, decreased to 219.9, and 397.2 salinities 5, 10, and 15 dS/m, respectively.

Table (77): ANOVA table for the Total tillers (no.)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	569591.38	13892.47	2.81	0.0003
Error	48	237423.46	4946.32		
Corrected Total	89	807014.84			
Replicate	2	4091.58	2045.79	0.41	0.6636 NS
Salinity	2	8419.79	4209.89	0.85	0.4333 NS
Replicate * Salinity	4	561.98	140.49	0.03	0.9984 NS
Irrigation	1	406.19	406.19	0.08	0.7757 NS
Salinity * Irrigation	2	5595.92	2797.96	0.57	0.5717 NS
Salinity(rep.*irr.)	6	19453.07	3242.17	0.66	0.6856 NS
Species	4	33463.94	8365.98	1.69	0.1674 NS
Salinity * Species	8	471411.67	58926.45	11.91	0.0001 **
Irrigation * Species	4	9194.40	2298.60	0.46	0.7613 NS
Salinity * Irr. * Spec.	8	16992.82	2124.10	0.43	0.8976 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (78): LSD for Total tiller (no.) (Variable: salinity)

Salinity	Mean
10 dS/m	**367.28 a**
5 dS/m	**355.71 a**
15 dS/m	**345.59 a**

Columns followed by the same letter are non-significant at level 0.05

Table (79): LSD for Total tiller (no.) (Variable: species)

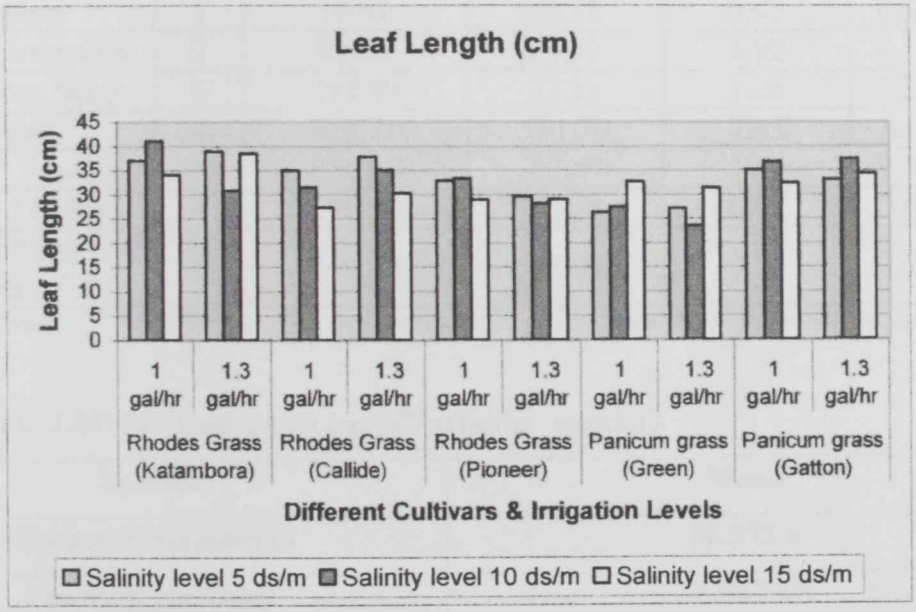
Species	Mean
Rhodes (Pioneer)	**380.26 a**
Rhodes (Callide)	**375.67 a**
Panicum (Green)	**350.96 a**
Rhodes (Katambora)	**337.37 a**
Panicum (Gatton)	**333.37 a**

Columns followed by the same letter are non-significant at level 0.05

Statestical analysis for salinity and species shows no difference between all its items and interactions.

Leaf Length (cm):

Figure (33): Leaf Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that Rhodes grass (Katambora) was affected by salinity. For example, leaf length at irrigation 1, was 37 cm, 41.03 cm, and 34.13 cm at saleneties 5, 10, and 15 dS/m respectively. Rhodes grass (Claide) however showed that it was affected significantly at both irrigation 1 and 2. For example, leaf length at irrigation 1 was 35.03

cm, 31.53 cm, and 27.43 cm at salinities 5, 10, and 15 dS/m, respectively. Also Rhodes grass (Pioneer) showed small, but significance changes in leaf length. At irrigation 2, leaf length was 29.66 cm, 28.2 cm, and 29.1 cm at salinities 5, 10, and 15 dS/m, respectively.

On the other hand, results showed that salinity had a significant effect on cultivars of Panicum grass. Leaf length of Panicum grass (Green) at irrigation 1 was 26.36 cm, 27.46 cm, and 32.63 cm at salinities 5, 10, and 15 dS/m, respectively. These results showed that leaf length was not significantly affected by salinity. Panicum grass (Gatton) was affected significantly.

Table (80): ANOVA table for the Leaf length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1805.76	44.04	1.72	0.0362
Error	48	1231.53	25.65		
Corrected Total	89	3037.29			
Replicate	2	43.91	21.95	0.86	0.4313 NS
Salinity	2	33.91	16.95	0.66	0.5210 NS
Replicate * Salinity	4	87.76	21.94	0.86	0.4976 NS
Irrigation	1	10.81	10.81	0.42	0.5193 NS
Salinity * Irrigation	2	98.66	49.33	1.92	0.1573 NS
Salinity(rep.*irr.)	6	193.99	32.33	1.26	0.2934 NS
Species	4	764.81	191.20	7.45	0.0001 **
Salinity * Species	8	326.45	40.80	1.59	0.1527 NS
Irrigation * Species	4	100.97	25.24	0.98	0.4253 NS
Salinity * Irr. * Spec.	8	144.46	18.05	0.70	0.6866 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (81): LSD for Leaf length (cm) (Variable: species)

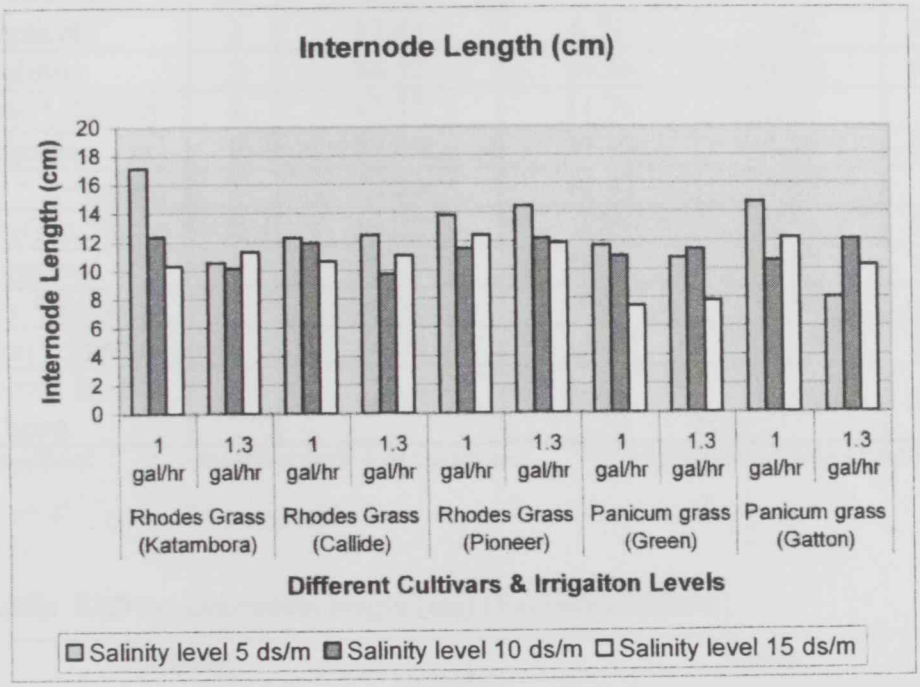
Species	Mean
Rhodes (Katambora)	**36.572 a**
Panicum (Gatton)	**34.867 ab**
Rhodes (Katambora)	**32.867 bc**
Rhodes (Pioneer)	**30.350 cd**
Panicum (Green)	**28.544 d**

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis for leaf length shows a highly significant difference between species. For example, the difference was highly significant between species 5, 2, and 3 (Panicum grass: Gatton, Rhodes grass: Claide, and Rhodes grass: Pioneer). Also, there waas a significant difference between species 1 and 5 (Rhodes grass: Katambora, Panicum grass: Gatton), and species 3, 4 (Rhodes grass: Pioneer, and Panicum grass: Green).

Internode length (cm):

Figure (34): Internodes Length (cm) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that the difference between salinity was significant (small). For example, internodes length for Rhodes grass (Katambora) at irrigation 1 gal/hr was 17.16 cm, 12.36 cm, and 10.33 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Internodes length of Rhodes grass (Claide and Pioneer) was significantly reduced. For example, internodes length of Rhodes grass (Claide) at irrigation 1 gal/hr was 12.3 cm, 11.9 cm, and 10.63 cm at salinities 5dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass was also showed affected significantly by salinity. For example, internodes length Pancium grass (Green) at irrigation 1 gal/hr , was 11.66 cm, 10.93, and 7.43 at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Internode length decreased from salinity 5 dS/m to salinity 15 dS/m. Also, Panicum grass (Gatton) was affected significantly when at different salinity. For example, at irrigation 1 gal/hr it was 14.7 cm, 10.6 cm, and 12.2 cm at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Table (82): ANOVA table for the Internodes length (cm)

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	458.92	11.19	2.60	0.0008
Error	48	206.83	4.30		
Corrected Total	89	665.76			
Replicate	2	12.43	6.21	1.44	0.2464 NS
Salinity	2	88.32	44.16	10.25	0.0002 **
Replicate * Salinity	4	47.17	11.79	2.74	0.0394*
Irrigation	1	37.89	37.89	8.79	0.0047 **
Salinity * Irrigation	2	22.84	11.42	2.65	0.0809 *
Salinity(rep.*irr.)	6	14.22	2.37	0.55	0.7673 NS
Species	4	67.05	16.76	3.89	0.0081 **
Salinity * Species	8	59.92	7.49	1.74	0.1137 NS
Irrigation * Species	4	54.28	13.57	3.15	0.0223 NS
Salinity * Irr. * Spec.	8	54.75	6.84	1.59	0.1533 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (83): LSD for Internodes length (cm) (Variable: salinity)

Salinity	Mean
5 dS/m	**12.5833 a**
10 dS/m	**11.2633 b**
15 dS/m	**10.1600 c**

Columns followed by the same letter are non-significant at level 0.05

Table (84): LSD for Internodes length (cm) (Variable: irrigation)

Irrigation	Mean
1 gal/hr	**11.9844 a**
1.3 gal/hr	**10.6867 b**

Columns followed by the same letter are non-significant at level 0.05

Table (85): LSD for Internodes length (cm) (Variable: species)

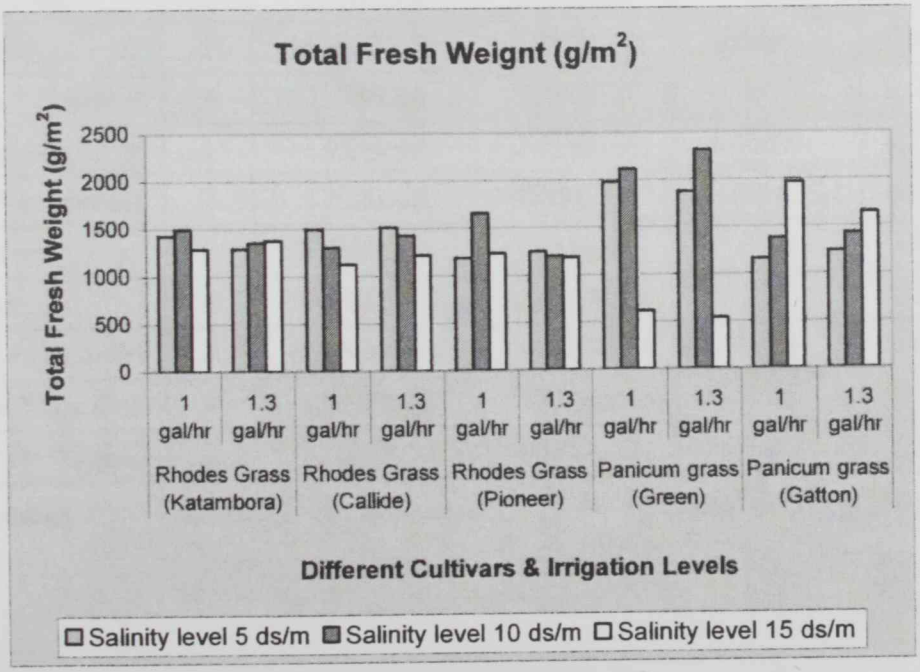
Species	Mean
Rhodes (Pioneer)	**12.6889 a**
Rhodes (Katambora)	**11.3944 a**
Rhodes (Callide)	**11.3333 ab**
Panicum (Gatton)	**11.3000 ab**
Panicum (Green)	**9.9611 b**

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that salinity had a highly significant affect when comparing treatments together. When looking at irrigation levels 1 gal/hr and 1.3 gal/hr , it was seen that there was a significant difference between levels. Species 3 and 1 (Rhodes grass: Pioneer, and Rhodes grass: Katambora) showed had different from one another. The same observation wasseen for species 5 (Panicum grass: Gatton) and species 2 (Rhodes grass: Claide).

Total fresh weight (g/m^2):

Figure (35): Total Fresh Weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that Rhodes grass (Katambora) was affected by salinity at irrigation 1 and 2. For example, at irrigation 1 it was 1428 g at salinity1, 1497.3 g at salinity 2, and 1287.7 g at salinity 3. Also, total fresh weight of Rhodes grass at irrigation (1 gal/hr) was 1494 g at salinity 5 dS/m, 1302.7 g at salinity 2, and 1125.3 g at salinity 3. Rhodes grass (Pioneer) was also affected by salinity. For example, at total fresh weight at irrigation (1 gal/hr), it was 1185.3 g, 1657.3 g, and 1233.3 g at salinities 5, 10, and 15 dS/m, respectively. We noted that there was a drastic change between salinity 1 and 2 (increasing), and between salinity 2 and 3, where it decreased again.

Panicum grass results showed an increasing fresh weight as salinity increased from 5 dS/m to 10 dS/m. This might be due to the fact that the plant becomes more tolerant of salinity as it grew bigger. For example, total fresh weight of Panicum grass (Green) at irrigation (1 gal/hr) was 1977.3 g, 2108 g, 614.67 g at salinities 5, 10, and 15 d/s/m. respectively.

Table (86): ANOVA table for the Total fresh weight (g) /m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	11865944.22	289413.27	2.18	0.0049
Error	48	6371039.99	132730		
Corrected Total	89	18236984.22			
Replicate	2	22760.62	11380.31	0.09	0.9180 NS
Salinity	2	1655175.55	827587.77	6.24	0.0039 **
Replicate * Salinity	4	21986.84	5496.71	0.04	0.9966 NS
Irrigation	1	11334.44	11334.44	0.09	0.7714 NS
Salinity * Irrigation	2	17029.42	8514.71	0.06	0.9379 NS
Salinity(rep.*irr.)	6	289540.53	48256.75	0.36	0.8983 NS
Species	4	673912.44	168478.11	1.27	0.2951 NS
Salinity * Species	8	8263043.55	1032880.44	7.78	0.0001 **
Irrigation * Species	4	189922.22	47480.55	0.36	0.8374 NS
Salinity * Irr. * Spec.	8	721238.57	90154.82	0.68	0.7073 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (87): LSD for Total Fresh Weight (g)/ m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	1540.00 a
5 dS/m	1440.00 a
15 dS/m	1215.67 b

Columns followed by the same letter are non-significant at level 0.05

Table (88): LSD for Total Fresh Weight (g) /m^2 (Variable: species)

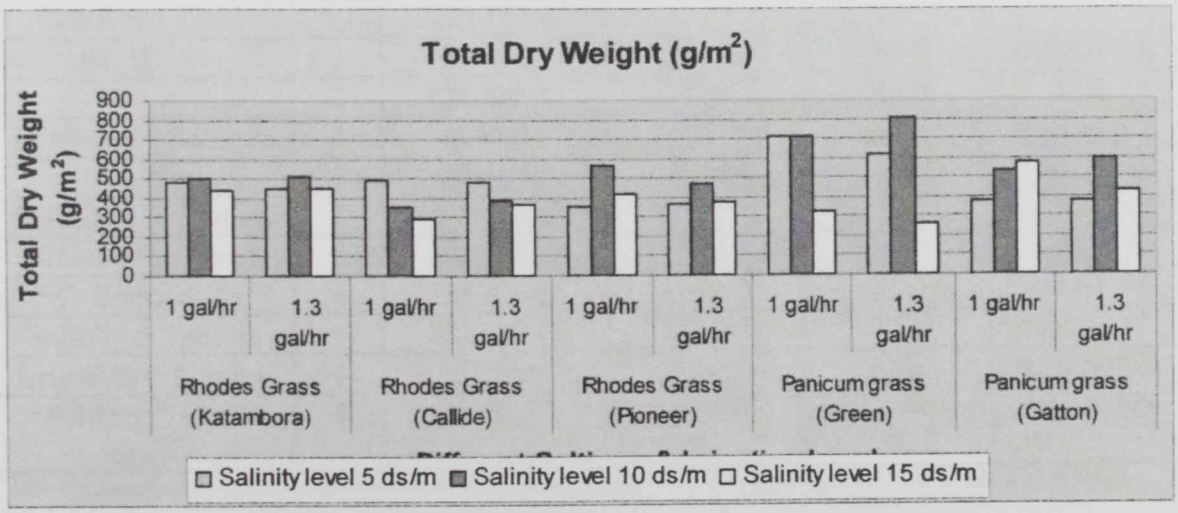
Species	Mean
Panicum (Green)	1525.9 a
Panicum (Gatton)	1468.2 a
Rhodes (Katambora)	1366.4 a
Rhodes (Callide)	1345.7 a
Rhodes (Pioneer)	1286.6 a

Columns followed by the same letter are non-significant at level 0.05

Results showed that there is no change between salinities 2 and 1 (10 dS/m & 5 dS/m). It also shows that the plant fresh weight increased from salinity 5 dS/m to 10 dS/m and then decreased in salinity 15 dS/m. This suggests that either there was a problem in the irrigation system (salt content), or it shows that the plant was tolerant at this stage. When comparing the species together, there is no difference between the species.

Total dry weight (g/m^2):

Figure (36): Total Dry Weight in 1m^2 (g) of difference cultivars under different salinity levels, and different irrigation level.



The total dry weight is mainly based on results obtained from total fresh weight. Results showed that salinity significantly affected some cultivars. For example, total dry weight of Rhodes grass (Katambora) at irrigation (1.3 gal/hr) was affected significantly. It was 483.33 g, 499.07 g, and 439.33 g at salinities 5, 10, and 15 ds/m, respectively. Rhodes grass (Claide) dry weight was affected (decreased) when treated with salinity. Total dry weight was 495.33 g at salinity 1, 354.6 g at salinity 2, and 296.56 g at salinity 3. Also, Rhodes grass (Pioneer) was affected significantly when treated with different salinity levels. For example, at irrigation 1 it was 358 g, 564.13 g, and 416 g as at salinities 3.

In Panicum grass, the salinity drastically affected (Green) cultivars where the dry weight decreased suddenly in salinity 2. For example at irrigation (1 gal/hr) total dry weight was 714.66 g, 706.66 g, and then suddenly decreased again to 325.33 g at salinities 5, 10, and 15 dS/m, respectively. Also, Panicum grass (Gatton) increased its total dry weight without being affected by the salinity. For example, at irrigation (1 gal/hr) it was 377.33 g, 533.2 g, and 572 g at salinities 5, 10, and 15 dS/m respectively.

Table (89): ANOVA table for the Total dry weight (g)/ m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1536749.86	37481.70	3.71	0.0001
Error	48	484402.02			
Corrected Total	89	2021151.88			
Replicate	2	7001.84	3500.92	0.35	0.7086 NS
Salinity	2	326008.90	163004.45	16.15	0.0001 **
Replicate * Salinity	4	6600.25	1650.06	0.16	0.9558 NS
Irrigation	1	2633.04	2633.04	0.26	0.6118 NS
Salinity * Irrigation	2	19525.46	9762.73	0.97	0.3874 NS
Salinity(rep.*irr.)	6	167875.93	27979.32	2.77	0.0214 *
Species	4	294768.81	73692.20	7.30	0.0001 **
Salinity * Species	8	625751.16	78218.89	7.75	0.0001 **
Irrigation * Species	4	13539.17	3384.79	0.34	0.8528 NS
Salinity * Irr. * Spec.	8	73045.25	9130.65	0.90	0.5204 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (90): LSD for Total Dry Weight (g)/ m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	538.74 a
5 dS/m	472.60 b
15 dS/m	391.57 c

Columns followed by the same letter are non-significant at level 0.05

Table (91): LSD for Total Dry Weight (g) /m^2 (Variable: irrigation)

Irrigation	Mean
1 gal/hr	473.04 a
1.3 gal/hr	462.23 a

Columns followed by the same letter are non-significant at level 0.05

Table (92): LSD for Total Dry Weight in 1m^2 (g) (Variable: species)

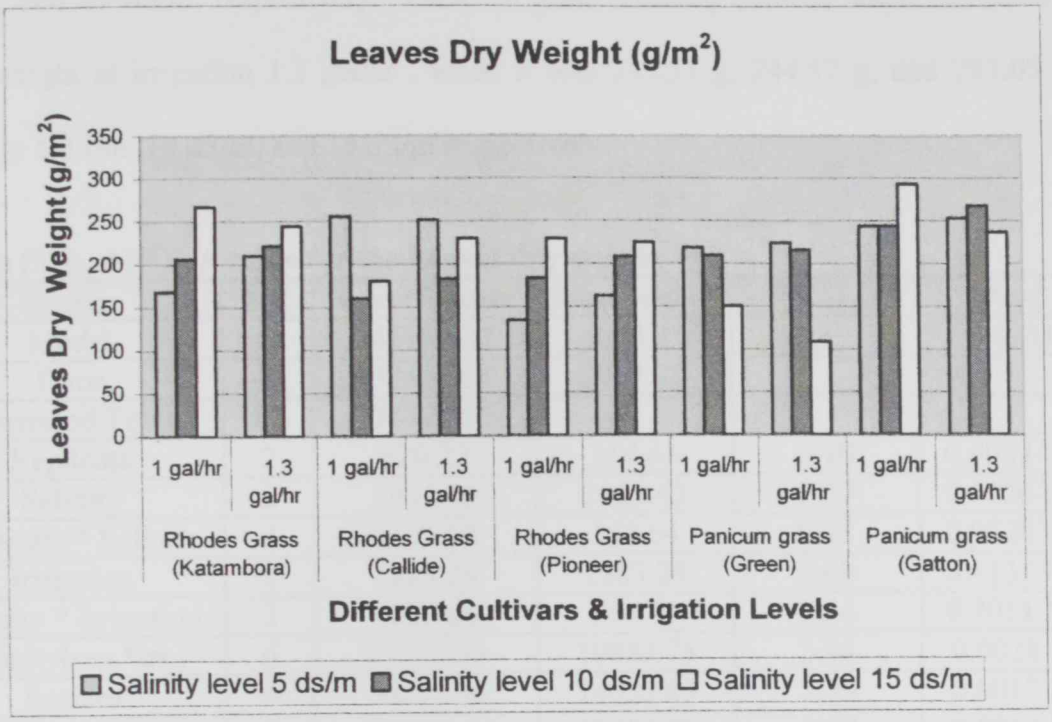
Species	Mean
Panicum (Green)	565.50 a
Panicum (Gatton)	480.33 b
Rhodes (Katambora)	468.93 b
Rhodes (Pioneer)	425.48 bc
Rhodes (Callide)	397.93 c

Columns followed by the same letter are non-significant at level 0.05

By looking at LCD values above, salinity, for example, was highly significant between different levels. It also shows that the salinity 2 (10 dS/m) produced more dry weight than salinity 1 (5 dS/m). On the other hand, irrigation levels showed no effect, between irrigation (1 gal/hr & 1.3 gal/hr). LSD for species shows that there was a highly significantly difference between species. For example, Panicum grass (Green) was significant different when compared to other species.

Leaves dry weight (g /m^2):

Figure (37): Leaves dry weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Salinity affected all species and cultivars. For example, in Rhodes grass (Katambora) at irrigation 1 gal/hr and 1.3 gal/hr , the dry leaf weight was affected of both irrigation levels, while the salinity increased as well. At irrigation 1.3 gal/hr , dry leaf weight was increasing significantly increased when it was 210.16 g, 221.46 g, and 244.3 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Rhodes grass (Claide) was also affected by salinity, at both irrigation 1 gal/hr and 1.3 gal/hr . At irrigation 1 gal/hr it was 256.1 g, 160.27 g, 180.5 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively. Rhodes grass (Pioneer) was not affected by salinity at all irrigation levels. At irrigation 1 gal/hr for example, it was 134.66 g, 183.46 g, 229.6 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass showed some decrease in dry leaf weight of some cultivars, and an increase in others. For example, Panicum grass (Green) was affected by salinity at irrigation 1 gal/hr when it was 218.77 g, 209.57 g, and 150.27 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Panicum grass (Gatton) showed some increased dry leaf weight at irrigation 1.3 gal/hr , when it was 243.57 g, 244.57 g, and 293.03 g at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Table (93): ANOVA table for the Leaves dry weight (g)/ m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	246162.20	6003.95	2.17	0.0051
Error	48	132610.61	2762.72		
Corrected Total	89	378772.82			
Replicate	2	529.27	264.63	0.10	0.9088 NS
Salinity	2	2044.86	1022.43	0.37	0.6926 NS
Replicate * Salinity	4	1402.58	350.64	0.13	0.9720 NS
Irrigation	1	1883.29	1883.29	0.68	0.4131 NS
Salinity * Irrigation	2	1976.86	988.43	0.36	0.7011 NS
Salinity(rep.*irr.)	6	65302.53	10883.75	3.94	0.0028 **
Species	4	56221.96	14055.49	5.09	0.0017 **
Salinity * Species	8	100997.76	12624.72	4.57	0.0003 **
Irrigation * Species	4	6954.71	1738.67	0.63	0.6439 NS
Salinity * Irr. * Spec.	8	8848.34	1106.04	0.40	0.9149 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant

Table (94): LSD for Leaves dry weight (g) /m^2 (Variable: irrigation)

Irrigation	Mean
1.3 gal/hr	219.98 a
1 gal/hr	210.83 a

Columns followed by the same letter are non-significant at level 0.05

Table (95): LSD for Leaves dry weight (g) /m^2 (Variable: species)

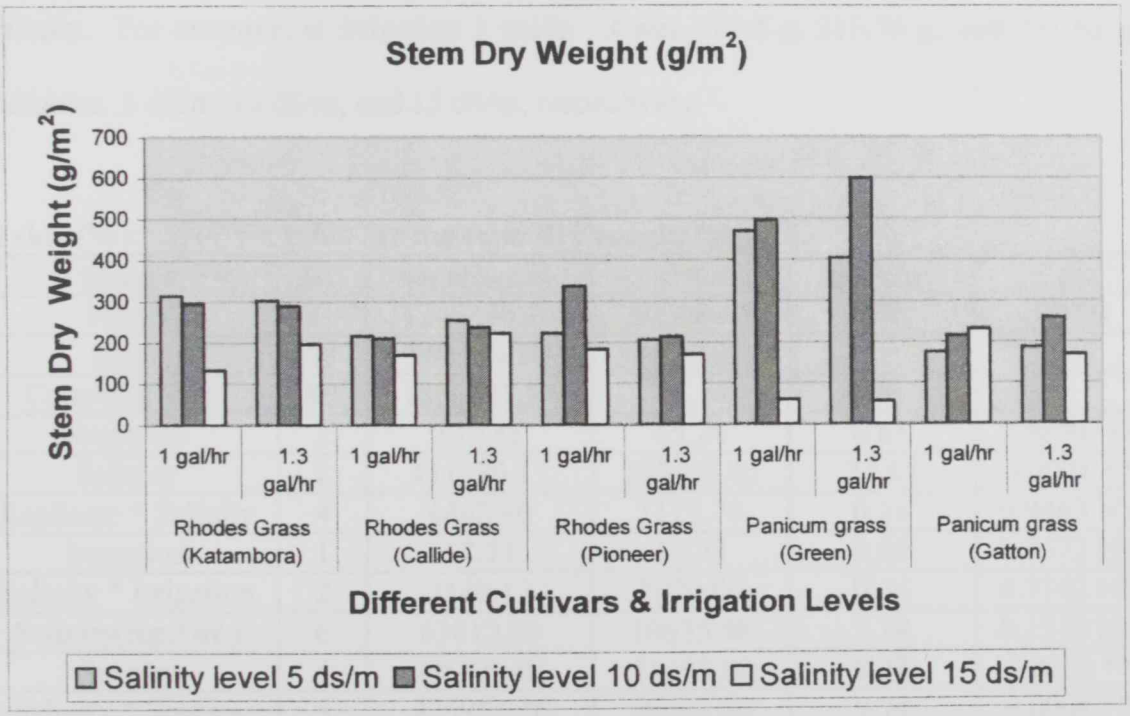
Species	Mean
Panicum (Gatton)	256.51 a
Rhodes (Katambora)	228.91 ab
Rhodes (Callide)	210.32 bc
Panicum (Green)	190.72 c
Rhodes (Pioneer)	190.58 c

Columns followed by the same letter are non-significant at level 0.05

Results from the above show that there was no difference between the two irrigation levels (1 gal/hr and 1.3 gal/hr). Species was highly significance in interaction between differenct species. For example, species 1 and 2 (Rhodes grass: Katambora and Rhodes grass: Claide) were significant different, while species like 4 and 3 (Panicum grass: Green and Rhdoes grass: Pioneer) has showed no difference in leaf dry weight. Species like 5 and 1 (Panicum grass: Gatton and Rhodes grass: Katambora) showed a small difference (significance) in interaction between them.

Stem dry weight (g /m^2:

Figure (38): Stem dry weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that Rhodes grass was affected drastically because of the effect of salinity. Stem dry weight at irrigation 1 gal/hr , it was 314.7 g, 294.2 g, and 133.93 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Claide), was also

affected because salinity reduced plant weight. Stem dry weight at irrigation 1.3 gal/hr it was 254.37 g, 237.37 g, and 223.83 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. On the other hand, Rhodes grass (Pioneer) was affected significantly when treated with different salinity levels. At irrigation 1.3 gal/hr , stem dry weight with 205.63 g, 213.83 g, and 170.5 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass (Green) was affected by salinity. Also, it started to increase form salinity 5 dS/m to salinity 10 dS/m, suddenly it have decreased its weight drastically when it reached salinity 15 dS/m. This might be due to excess amounts of salinity in water which caused a shock to the plant, and a decrease in plant weight. Stem dry weight at irrigation 1 gal/hr it was 470.13 g, 497g, and 61.36 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. On the other hand, Panicum grass (Gatton) was not affected salinity. For example, at irrigation 1 gal/hr it was 175.8 g, 215.76 g, and 231.63 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Table (96): ANOVA table for the stem dry weight (g)/ m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1246336.76	30398.45	4.98	0.0001
Error	48	293184.80	6108.01		
Corrected Total	89	1539521.57			
Replicate	2	130.48	65.24	0.01	0.9894 NS
Salinity	2	411326.11	205663.05	33.67	0.0001 **
Replicate * Salinity	4	4462.80	1115.70	0.18	0.9463 NS
Irrigation	1	17.77	17.77	0.00	0.9572 NS
Salinity * Irrigation	2	4140.12	2070.06	0.34	0.7142 NS
Salinity(rep.*irr.)	6	63812.88	10635.48	1.74	0.1318 NS
Species	4	205970.01	51492.50	8.43	0.0001 **
Salinity * Species	8	475951.26	59493.90	9.74	0.0001 **
Irrigation * Species	4	22904.76	5726.19	0.94	0.4504 NS
Salinity * Irr. * Spec.	8	57620.53	7202.56	1.18	0.3311 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Table (97): LSD for stem dry weight (g)/ m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	309.83 a
5 dS/m	275.25 a
15 dS/m	152.29 b

Columns followed by the same letter are non-significant at level 0.05

Table (98): LSD for stem dry weight (g) /m^2 (Variable: species)

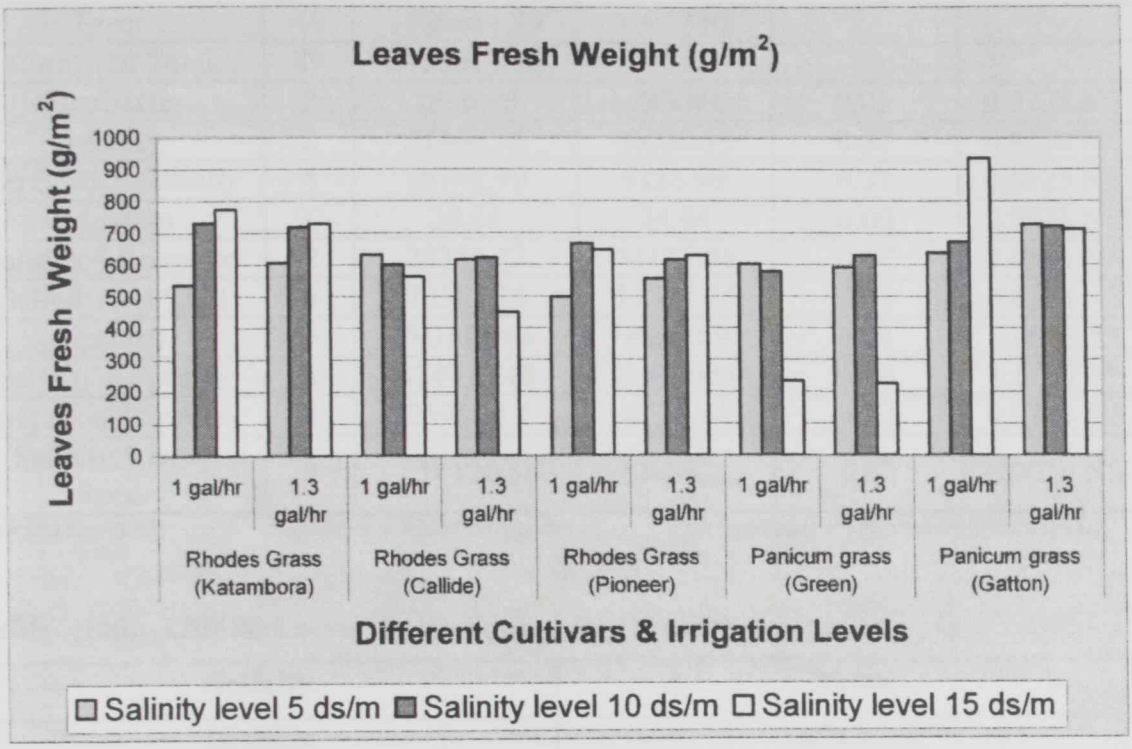
Species	Mean
Panicum (Green)	338.56 a
Rhodes (Katambora)	242.76 b
Rhodes (Pioneer)	222.23 b
Rhodes (Callide)	219.12 b
Panicum (Gatton)	206.28 b

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was no significant difference between, salinity 10 dS/m, and 5 dS/m. Salinity 3 (15 dS/m) was markedly different, when comparing it with the rest of the salinities. For species such as 1, 3, 2, and 5 (Rhodes grass: Katambora, Rhodes grass: Pioneer, Rhodes grass: Claide, and Panicum grass: Gatton) there was no difference between them. When comparing species 4 (Panicum grass: Green) difference is noticed observed for the other species.

Leaves Fresh weight (g/m^2):

Figure (39): Leaves fresh weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Salinity did not affect Rhodes grass (Katambora). For example, fresh leaf weight at irrigation 1 gal/hr it was 536.7 g, 731.23 g, and 774.46 g at salinities of 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Also, Rhodes grass (Claide) was affected by salinity. For example, at irrigation 1.3 gal/hr it was 613.83 g, 620.8 g, and 450.27 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Pioneer), was not affected by salinity at irrigation 1.3 gal/hr as it was 555 g, 615.4 g, and 628.5 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass (Green) at the same time was drastically affected by salinity at both irrigations levels. At irrigation 1 gal/hr for example, fresh leaf weight was 600.9 g, 577.3 g, and 234.9 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Panicum grass (Gatton) was not affected by salinity at both irrigation levels, and it was shown to the salinity tolerant plant. At irrigation 1 gal/hr , fresh leaf weight was 636.2 g, 671.2 g, and 936.23 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Table (99): ANOVA table for the Leaves fresh weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	1989854.58	48533.03	1.62	0.0549
Error	48	1440663.39	30013.82		
Corrected Total	89	3430517.98			
Replicate	2	1686.98	843.49	0.03	0.9723 NS
Salinity	2	52460.27	26230.13	0.87	0.4238 NS
Replicate * Salinity	4	36743.99	9185.99	0.31	0.8725 NS
Irrigation	1	24.64	24.64	0.00	0.9773 NS
Salinity * Irrigation	2	28354.72	14177.36	0.47	0.6264 NS
Salinity(rep.*irr.)	6	74365.56	12394.26	0.41	0.8668 NS
Species	4	793123.66	198280.91	6.61	0.0003 **
Salinity * Species	8	874952.48	109369.06	3.64	0.0022 **
Irrigation * Species	4	26940.17	6735.04	0.22	0.9235 NS
Salinity * Irr. * Spec.	8	101202	12650.25	0.42	0.9024 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (100): LSD for Leaves fresh weight (g)/m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**654.11 a**
15 dS/m	**606.91 a**
5 dS/m	**599.66 a**

Columns followed by the same letter are non-significant at level 0.05

Table (101): LSD for Leaves fresh weight (g) /m^2 (Variable: species)

Species	Mean
Panicum (Gatton)	**733.54 a**
Rhodes (Katambora)	**711.23 ab**
Rhodes (Pioneer)	**601.09 bc**
Rhodes (Callide)	**579.73 cd**
Panicum (Green)	**475.54 d**

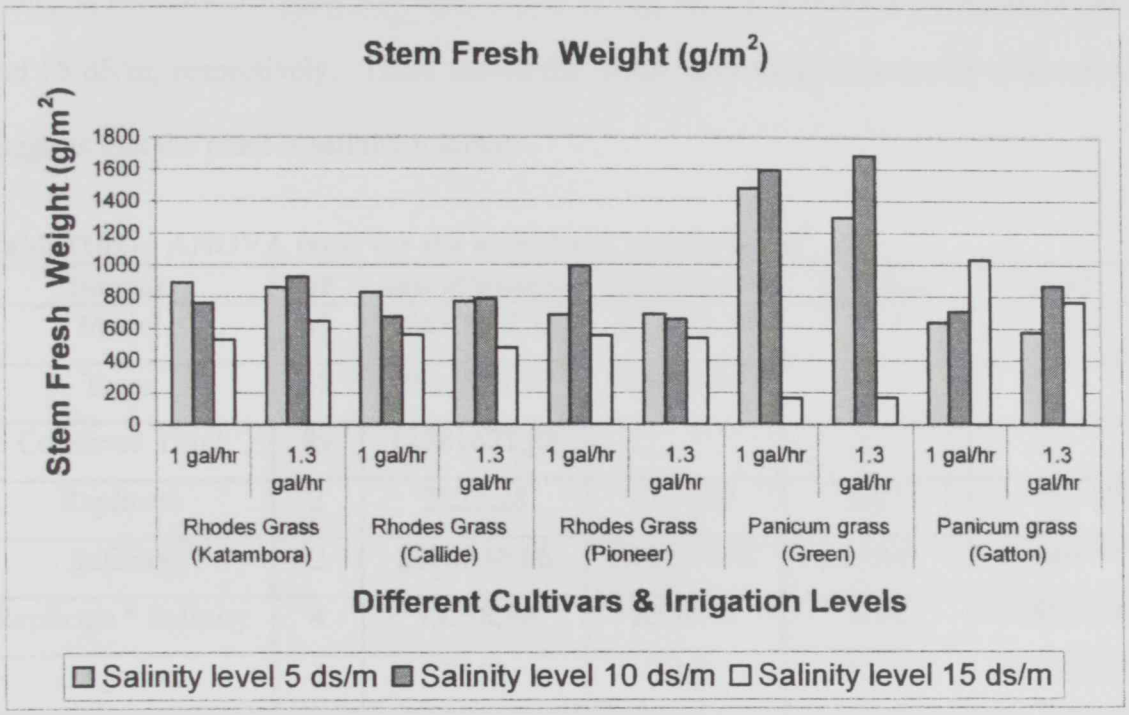
Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was no difference between different levels of salinity. There was a highly-significance difference between different kinds of species. For example, species 5 (Panicum grass: Gatton) was significantly different, when

comparing it with species like 3, 2, and 4 (Rhodes grass: Pioneer, Rhodes grass: Claide, and Panicum grass: Green).

Stem fresh weight (g/m^2):

Figure (40): Stem fresh weight in $1m^2$ (g) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that Rhodes grass (Katambora) was affected drastically at irrigation level (1 gal/hr) and (1.3 gal/hr). For example, stem fresh weight at irrigation 1 gal/hr it was 891.2 g, 759.33 g, and 532.6 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Claide) was also affected significantly when treated with salinity. At irrigation 1 gal/hr , for example, stem fresh weight was 829.63 g, 675.57 g, and 563.27 g at salinities 5dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Pioneer) was affected significantly due to salinity. Rhodes grass (Pioneer), for example at irrigation 1.3 gal/hr was 690.6 g, 659.97 g, and 539.17 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass was also affected by salinity. For example at irrigation 1 gal/hr , stem fresh weight was 1477.9 g, 1592.6 g, and 166.23 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Almost the same trend was observed for irrigation 2. This might be due to the excess salt in irrigation water, or to low irrigation (small quantity).

Panicum grass (Gatton) was not affected by the salinity. At irrigation 1 gal/hr for example, stem fresh weight was 638, 705.33 g, and 1033 g at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. There shows that plant stem weight increased with salinity, suggests that the plant is salinity tolerant.

Table (102): ANOVA table for the stem fresh weight (g)/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	10450047.35	254879.20	4.17	0.0001
Error	48	2931573.93	61074.45		
Corrected Total	89	13381621.28			
Replicate	2	2227.28	1113.64	0.02	0.9819 NS
Salinity	2	2890356.66	1445178.33	23.66	0.0001 **
Replicate * Salinity	4	33238.96	8309.74	0.14	0.9682 NS
Irrigation	1	7462	7462	0.12	0.7282 NS
Salinity * Irrigation	2	146242.16	73121.08	1.20	0.3109 NS
Salinity(rep.*irr.)	6	594133.80	99022.30	1.62	0.1618 NS
Species	4	1367955.53	341988.88	5.60	0.0009 **
Salinity * Species	8	4911161.29	613895.16	10.05	0.0001 **
Irrigation * Species	4	87588.12	21897.03	0.36	0.8368 NS
Salinity * Irr. * Spec.	8	409681.50	51210.18	0.84	0.5737 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (103): LSD for stem fresh weight (g)/m^2 (Variable: salinity)

Salinity	Mean
10 dS/m	**937.14 a**
5 dS/m	**871.80 a**
15 dS/m	**528.55 b**

Columns followed by the same letter are non-significant at level 0.05

Table (104): LSD for stem fresh weight (g)/m^2 (Variable: species)

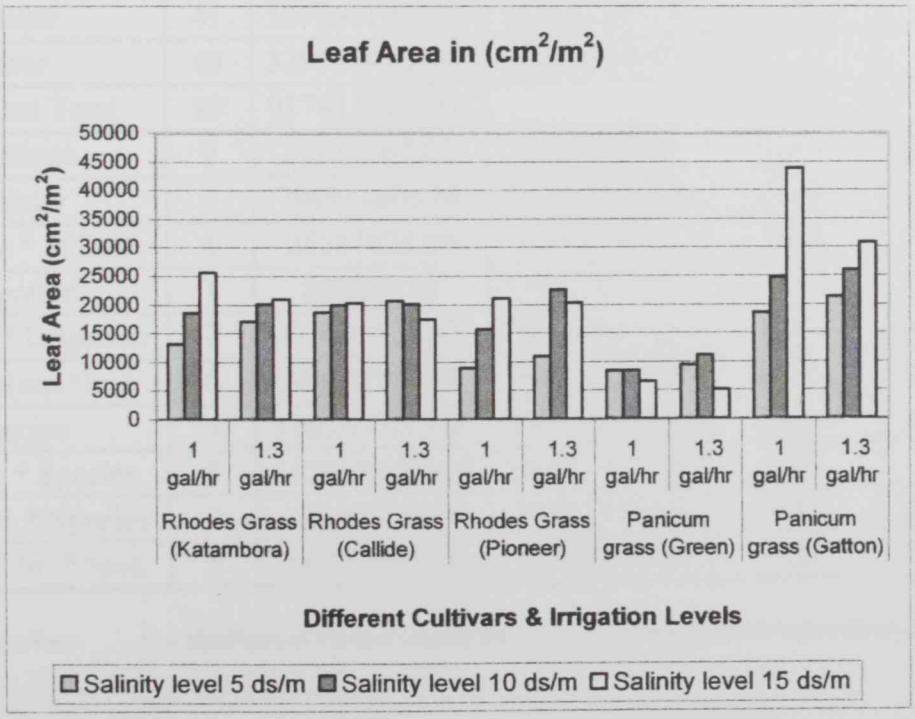
Species	Mean
Panicum (Green)	1018.03 a
Panicum (Gatton)	764.58 b
Rhodes (Katambora)	740.49 b
Rhodes (Pioneer)	687.73 b
Rhodes (Callide)	684.98 b

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was a highly significant difference between salinity 3 (15 dS/m), and the rest of salinity levels. Species as well showed a highly significant difference between species 4 (Panicum grass: Green) and the rest of the species. Species 5, 1, 3, and 2 (Rhodes grass: Gatton, Rhodes grass: Katambora, Rhodes grass: Pioneer, and Rhodes grass: Claide) showed no difference in between these species.

Leaf area (cm^2/m$^{2)}$:

Figure (41): Leaf Area in 1m^2 (cm^2) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that salinity had no effect on Rhodes grass (Katambora). For example, leaf area at irrigation 1 gal/hr it was 13195 cm^2, 18651 cm^2, and 25663 cm^2 at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Claide), was not affected by salinity at irrigation 1 gal/hr , but was affected significantly at irrigation 1.3 gal/hr . For example, leaf area at irrigation 1 gal/hr it was 18694 cm^2, 19957 cm^2, and 20363 cm^2 at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Rhodes grass (Pioneer) was not affected by salinity, and the leaf area was increasing while the salinity increases. For example, at irrigation 1 gal/hr it gained 8889.5 cm^2, 15641 cm^2, and 21059 cm^2 at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively.

Panicum grass (Green) was affected by salinity. At rrigation1 gal/hr it leaf area was 8509.9 cm^2, 8450.5 cm^2, and 6524.3 cm^2 at salinities 5 dS/m, 10 dS/m, and 15 dS/m, respectively. Panicum grass (Gatton) was not affected by salinity. For example, at irrigation 1 gal/hr it gained 18584 cm^2, 24705 cm^2, and 43849 cm^2 at salinity 5 dS/m, 10 dS/m, and 15 dS/m respectively.

Table (105): ANOVA table for the Leaf area cm^2/m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	5878661904.21	143381997.66	2.09	0.0074
Error	48	3295454369.46	68655299.36		
Corrected Total	89	9174116273.67			
Replicate	2	22010367.82	11005183.91	0.16	0.8523 NS
Salinity	2	794911604.68	397455802.34	5.79	0.0056 **
Replicate * Salinity	4	25161623.80	6290405.95	0.09	0.9847 NS
Irrigation	1	880269.34	880269.34	0.01	0.9103 NS
Salinity * Irrigation	2	127657928.18	63828964.09	0.93	0.4017 NS
Salinity(rep.*irr.)	6	286620928.80	47770154.80	0.70	0.6542 NS
Species	4	3202505275.60	800626318.90	11.66	0.0001 **
Salinity * Species	8	1126181074.30	140772634.28	2.05	0.0600 *
Irrigation * Species	4	112495163.60	28123790.90	0.41	0.8008 NS
Salinity * Irr. * Spec.	8	180237668.05	22529708.50	0.33	0.9511 NS

NS= Not Significant *** = Significant at 5% level (Significant)** **** = Significant at 1% level (High Significant)**

Table (106): LSD for Leaf area cm^2/m^2 (Variable: salinity)

Salinity	Mean
15 dS/m	21928 a
10 dS/m	19306 a
5 dS/m	14735 b

Columns followed by the same letter are non-significant at level 0.05

Table (107): LSD for Leaf area cm^2/m^2 (Variable: species)

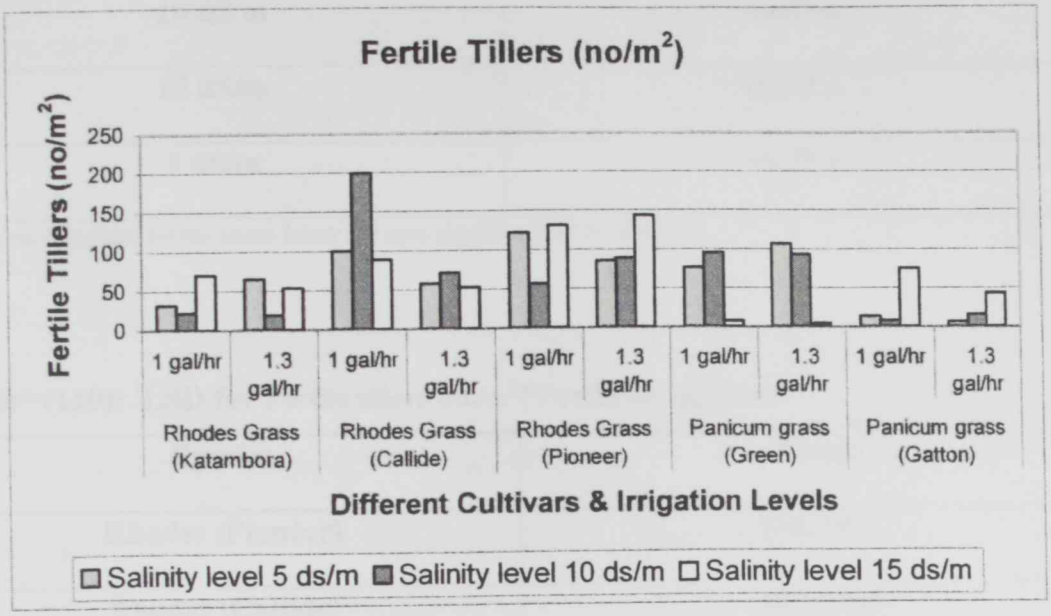
Species	Mean
Panicum (Gatton)	27524 a
Rhodes (Katambora)	20466 b
Rhodes (Callide)	19575 b
Rhodes (Pioneer)	16595 b
Panicum (Green)	9122 c

Columns followed by the same letter are non-significant at level 0.05

Statistical analysis showed that there was no difference between salinity 2 (10 dS/m) and salinity 3(15 dS/m). Also, salinity 1 (5 dS/m) produced less leaf area, might be due to defect in the irrigation system. LSD showed that there was no difference between species 1, 2, and 3 (Rhodes grass: Katambora, Rhodes grass: Claide, Rhodes grass: Pioneer). Both species 5 and 4 (Panicum grass: Gatton and Panicum grass: Green) was significantly different between them, and between the rest of the species.

Fertile tillers (no/m$^{2)}$:

Figure (42): Fertile Tillers in 1m^2 (no.) of difference cultivars under different salinity levels, and different irrigation level.



Results showed that salinity affected fertile tillers in all species and cultivars. It also showed that fertile tillers numbers were not constant over all of the cultivars. For an example, Rhodes grass (Katambora) at irrigation (1 gal/hr) was 31.66, 21.96, and 70.1 no at salinities 5, 10, and 15 dS/m, respectively. Rhodes grass (Pioneer) at irrigation (1 gal/hr) gained 121.77, 56.03, and 130.67 no at salinities 5, 10, and 15 dS/m, respectively.

Table (108): ANOVA table for the Fertile tillers no./m^2

Source	DF	Sum of Squares	Mean Square	F Value	Pr>f
Model	41	219174.95	5345.73	2.39	0.0020
Error	48	107344.14	2236.33		
Corrected Total	89	326519.09			
Replicate	2	12408.45	6204.22	2.77	0.0724 NS
Salinity	2	55.06	27.53	0.01	0.9878 NS
Replicate * Salinity	4	3836.92	959.23	0.43	0.7870 NS
Irrigation	1	4251.84	4251.84	1.90	0.1743 NS
Salinity * Irrigation	2	1118.46	559.23	0.25	0.7798 NS
Salinity(rep.*irr.)	6	11246.73	1874.45	0.84	0.5467 NS
Species	4	78420.83	19605.20	8.77	0.0001 **
Salinity * Species	8	74541.77	9317.72	4.17	0.0008 **
Irrigation * Species	4	17646.60	4411.65	1.97	0.1137 NS
Salinity * Irr. * Spec.	8	15648.25	1956.03	0.87	0.5443 NS

NS= Not Significant * = Significant at 5% level (Significant) ** = Significant at 1% level (High Significant)

Table (109): LSD for Fertile tillers no./2 (Variable: salinity)

Salinity	Mean
10 dS/m	68.07 a
15 dS/m	66.58 a
5 dS/m	66.28 a

Columns followed by the same letter are non-significant at level 0.05

Table (110): LSD for Fertile tillers no./m^2(Variable: species)

Species	Mean
Rhodes (Pioneer)	104.20 a
Rhodes (Callide)	94.98 ab
Panicum (Green)	65.79 bc
Rhodes (Katambora)	43.16 cd
Panicum (Gatton)	26.75 d

Columns followed by the same letter are non-significant at level 0.05

Above results showed that there was no difference (non-significant) between the salinity levels in its effect on the plant. While the species showed a huge difference (highly significant) between the cuts.

Plant Chemical Analysis:-

1. NDF
2. ADF
3. Protein
4. Dry matter
5. Ash

NDF: Schroeder (1994) stated that "the NDF volume is the total cell wall, which is compromised of the ADF fraction plus hemi cellulose. Neutral detergent fiber values are important in ration formulation because they affect an amount of forage the animal can consume. As NDF percentage increases, dry matter intake will generally decrease". On the other hand forage resources from the internet mentioned that "Neutral detergent fiber is the percentage of cell wall material. The lower the NDF percentage, the more an animal will digest. A low percentage of NDF is desirable. Low NDF usually indicates high intake by the animal".

Table (111): NDF percentage in the cultivar tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	63.7	67.3	68.8	68.5	65.6	66.4	62	65.6	62.8	63.5
10 dS/m	67	65.9	69.8	65.1	68.2	68.8	65.2	63.4	66.2	64.4
15 dS/m	68	68	68.7	67.3	65.1	64	68.6	65.7	65.3	66.3

By comparing the numbers in table no.(1) we noticed that there were few significant differences between the percentages of NDF, regardless of the species, irrigation level and the salinity level. For an example, under 5 dS/m level of salinity Rhodes grass (Katambora) NDF value was 63.7% (Irrigation 1 gal/hr) and 67.3% at (Irrigation 1.3 gal/hr), where as at the same level of salinity Rhodes grass (Claide) values were 68.8%(Irrigation 1 gal/hr) and 63.4% at (Irrigation 1.3 gal/hr). At salinity level

(2), Panicum grass (Green) gained 65.2% at Irrigation 1 gal/hr and 64.4 % at Irrigation 1.3 gal/hr . However at salinity level (3) Rhodes grass (Katambora) values were 68% at (Irrigation 1 gal/hr), Rhodes grass (Claide) values were 68.7% at (Irrigation 1 gal/hr), and Rhodes grass (Pioneer) gain 65.1 at (Irrigation 1 gal/hr). These results indicate that these genotypes were not affected by the salinity level or the irrigation level. These suggest that they are salt tolerant plants, and can produce the desired fiber for the animal feed under the same conditions.

ADF:

Table (112): ADF percentage in the cultivar tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	34.5	36.1	37.3	37.9	35.2	37	35.1	36.2	35.2	35.6
10 dS/m	35.7	35.7	37.5	34.3	36.3	37.6	35.4	33.5	35.8	36
15 dS/m	33.2	36.5	35.7	34.5	34.1	32.1	35.3	35.1	33	34.2

Plant fiber consists of four components: cellulose, hemi cellulose, lignin, and silica. The primary source of fiber comes from forages. ADF is associated with low digestibility in feeds. The lower the ADF, the more feed an animal well consume, therefore, a low ADF percentage is important. As described before for "NDF", there is no difference in percentage of ADF according to data shown in the table no. (2). For example, under 5 dS/m level of salinity Rhodes grass (Katambora) values were 34.5% at (Irrigation 1 gal/hr), Rhodes grass (Claide) values were 37.3 % at (Irrigation 1 gal/hr), Rhodes grass (Pioneer) values were 35.1% at (Irrigation 1 gal/hr), Panicum grass (Green) values were 35.1% and Panicum grass (Gatton) values were 35.2% at (Irrigation 1 gal/hr).

By comparing the number from different species as mentioned above, the irrigation level and salinity show that they are similar, and with a very small difference between the numbers.

Dry Matter (%):

Table (113): Dry Matter percentage in the cultivar tissues according to the salinity

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	89.9	93.4	92.9	94	93.5	93	93.5	92.4	92.9	92
10 dS/m	91.6	92	92.3	92.6	92.4	91.8	92.6	92	92.6	92.2
15 dS/m	93	93.5	92.6	93	92.6	93.2	92.8	92.3	92.8	92

Dry matter is the percentage of feed that is not water. Table no.(3) shows that under 5 dS/m level of salinity Rhodes grass (Katambora) values were 89.9% (at Ir1), Rhodes (2) values were 92.9% at (Irrigation 1 gal/hr), Rhodes grass (Pioneer) values were 93.5% at (Irrigation 1 gal/hr), Panicum grass (Green) gained 93.5% at (Irrigation 1 gal/hr) and Panicum grass (Gatton) values were 92.9% at (Irrigation 1 gal/hr). None of these differences were significant at the 5 % level of probability.

Protein (%):

Table (114): Protein percentage in the cultivars tissue at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	5.02	4.65	4.64	4.69	4.49	4.66	5.49	4.91	5.64	5
10 dS/m	5.17	5.33	5.28	5.19	5.23	5.34	5.68	6.74	5.53	5.87
15 dS/m	5.89	5.59	5.5	5.45	5.46	5.77	7.98	7.22	7.5	5.87

The protein in the forage can be determined by measuring the total nitrogen and multiplying by a constant number (6.25). In general, medium to high protein content is desirable since this reduces the need for supplemental protein source.

Pessarakeli, 1994 reported that "Salinity in the majority of the cases lowers the level of protein is salt-stressed plants as a result of the decreased synthesis of protein as well as increased activities of protein hydrolyzing enzymes. In certain cases, however, are increased protein level is noticed under salinization, possibly as a result of the increased synthesis of salt-induced proteins or the decreased activities of protyolytic enzymes."

According to the table no.(4), under 5 dS/m salt level Rhodes (1) values were 5.02 % (at Ir 1 gal/hr), Rhodes (2) values were 4.64% (at Ir 1 gal/hr), while under 15 dS/m salinity level Panicum (Green) values were 7.98% (at Ir 1 gal/hr) and Panicum (Gatton) values were 7.5 % (at Ir 1 gal/hr). These results indicate that there is a simple difference between the Rhodes species (cultivars), due to the difference in the salinity level. At the same time, Panicum grass approves that under 15 dS/m produced protein more than the Rhodes grass under the same salinity level.

Ash:

Table (115): Ash percentage in the cultivars tissue at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	11.1	11	11.1	11.8	11.4	10.9	12	11.6	12.4	12
10 dS/m	10.9	11.3	11.1	11.3	11.1	11.3	11.7	12	11.7	11.8
15 dS/m	11.3	11.4	12.6	11.4	11.3	11.4	11.2	11.1	12.3	12.3

The results in the table above shows that there are a very small difference between the species in general, which means that the salinity did not have any effect on the Ash % at all in the salinity levels, or the irrigation level as well. However, when comparing the ash and minerals content, it is obvious that salinity effect was almost stable and did not have that much effect on the contents (of ash and minerals) while the salinity increases from 5, 10, and 15 dS/m.

Discussion of Ions concentration in the plant tissue

1. Ca (%): Jimmy and Gerald found that "Calcium is absorbed as the cation Ca++ and exists in a delicate balance with Mg and K in the plant. Too much of any one to these elements may cause insufficiencies of the other two."

Table (116): Ca percentage in the cultivars tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	0.51	0.54	0.6	0.99	0.67	0.66	0.53	0.5	0.55	0.55
10 dS/m	0.57	0.7	0.58	0.62	0.65	0.73	0.57	0.6	0.55	0.57
15 dS/m	0.54	0.64	0.59	0.57	0.61	0.62	0.62	0.57	0.6	0.62

Table (6) Shows that under 5 dS/m of salt content, calcium concentrations were 0.51% at (Irrigation 1 gal/hr) and 0.54% at (Irrigation 1.3 gal/hr) which means that it has high content of that ion. By comparing calcium concentration in Rhodes grass (Katambora) at 5 dS/m, 10 dS/m and 15 dS/m we can see that there were no differences between salt levels since it is 0.51% at (Irrigation 1 gal/hr) at 5 dS/m 0.57% at 10 dS/m and 0.54 (Irrigation 1 gal/hr) at 15 dS/m. Statistical analysis is not available, since there is no replicate of the tests.

For Panicum grass (Green) species, under 5 dS/m salt level, the calcium concentration was 0.53% at (Irrigation 1 gal/hr), and 0.50 % at (Irrigation 1.3 gal/hr). Under 10 dS/m salt content in Panicum grass (Gatton) species it was 0.55 % at (Irrigation 1 gal/hr), 0.55 % at (Irrigation 1.3 gal/hr), 0.57% at (Irrigation 1.3 gal/hr).

2. K (%): Saskachewan, (2002) reported that" Potassium is utilized by a plant in the development of strong stems. This macronutrient also assists the plant in obtaining a higher tolerance to disease and helping to assists the plant in its use of water." Also

Jimmy and Gerald, 1989 said that "Potassium (K) is absorbed by plants in larger amounts than any other minerals element except N and, in some cases, Ca. Potassium is supplied to plants by soil mineral, organic materials and inorganic fertilizer."

Table (117): K percentage in the cultivars tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	1.2	1.33	1.57	0.7	1	1.54	2.66	3.19	2.18	2.29
10 dS/m	1.57	1.49	1.63	1.56	1.22	1.39	3.38	4.43	2	2.21
15 dS/m	1.54	1.68	1.35	1.29	1.23	1.19	2.48	2.68	2.11	1.86

By comparing the numbers in Table (7), we can see that there is a difference in the concentration of K between the cultivars of the two species. For example, Rhodes grass (Katambora) at 5 dS/m had a concentration of K of 1.2 % at (Irrigation 1 gal/hr) and 1.3 % at (Irrigation 1.3 gal/hr). At 10 dS/m it was 1.57% at (Irrigation 1 gal/hr) and 1.49% at (Irrigation 1.3 gal/hr). According to the mean separator, there is a difference between 5 dS/m, and 10 dS/m but there was no difference between 10 dS/m and 15 dS/m. This means that "K" accumulated more in the plant tissue in salinities 10 and 15 than salinity 5 dS/m.

Panicum grass (Green) showed differences in the salt level in the plant tissue. For example, at salt level 5 dS/m the K concentration in Panucum grass (Green) was 2.66% at (Irrigation 1 gal/hr) and 3.19% at (Irrigation 1.3 gal/hr). At salt level 10 dS/m it has 3.38% at (Irrigation 1 gal/hr) and 4.43% at (Irrigation 1.3 gal/hr). At salt level 15 dS/m it ahs 2.48% dS/m at (Irrigation 1 gal/hr) and 2.68 at (Irrigation 1.3 gal/hr). Paniucum grass (Gatton) showed almost no difference between different salinity levels and also between irrigation water qualities.

The (K %) in all the species, and at all salinity, and irrigation levels was in the high range except the Rhodes grass which is in the medium level. K% in Panicum grass

was high, but did not show any symptoms of being effected by the high level. Statistical analysis is not available, since there is no replicate of the tests.

3. Mg (%):

Table (118): Mg percentage in the cultivars tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	0.19	0.1	0.2	1.66	0.2	0.2	0.48	0.45	0.41	0.41
10 dS/m	0.2	0.2	0.2	0.2	0.19	0.24	0.48	0.46	3.61	0.4
15 dS/m	0.19	0.19	0.21	0.19	0.18	0.19	0.33	0.44	0.4	0.3

By comparing the different numbers in the table no. (8) regardless of the species or the salinity level or the irrigation level, we can see that the Mg % is in the sufficient ratio, which means that the plants at all the salinity levels are adapted these concentration. And the critical level that the plant can not grow in is between 0.5 to 1 %. For Mg percentage in Rhodes is lower than the Panicum. On the other hand, at 5 dS/m salt level in Rhodes grass (Katambora) it has 0.19% at (Irrigation 1 gal/hr) and 0.1% at (Irrigation 1.3 gal/hr), at the same time Panicum grass (Green) at 5 dS/m has 0.48% at (Irrigation 1 gal/hr) and 0.45% at (Irrigation 1.3 gal/hr) due to the difference in specification of each plant and its cultivars. Statistical analysis is not available, since there is no replicate of the tests.

4. Na (%):

Table (119): Na percentage in the cultivars tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	1.1	1.23	0.99	1	1	1.12	1	0.53	1.58	1.53
10 dS/m	1.33	1.51	1.28	1.44	1.62	1.5	0.8	0.26	1.32	1.52
15 dS/m	1.36	1	1.52	1.41	1.3	1.38	0.69	0.67	1.58	1.41

Results from table no (9) show that under 5 dS/m salt level, the Na% in Rhodes grass (Katambora) was 1.1% at (Irrigation 1 gal/hr) and 1.23% at (Irrigation 1.3 gal/hr). At 10 dS/m salt level Na% was 1.33% at (Irrigation 1 gal/hr) and 1.51% at (Irrigation 1.3 gal/hr). These data indicates that there are small difference between the salinities and irrigation level. Differences in Na %, except in Panicum(Green) at all the salinity levels, were not for all irrigation and salt levels. Statistical analysis is not available, since there is no replicate of the tests.

5. Cl (%): Jimmy and Gerald, 1989 stated that "Chloride (Cl) is needed in relatively large quantities in plant nutrition. However, the abundance of Cl from many sources in the environment means that Cl deficiencies in plant are rare. Excess and toxicity of Cl are more frequently occurring problems are deficiencies."

Table (120): Cl percentage in the cultivars tissues at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	2.55	2.53	2.1	2.6	2.46	2.65	1.92	1.82	2.12	1.92
10 dS/m	2.94	2.99	2.94	2.99	3.09	2.21	2.46	2.55	2.02	2.12
15 dS/m	2.31	2.12	3.09	2.55	2.41	2.6	2.41	1.78	2.26	2.17

From Table (10), Cl concentrations are considered high in all of the salinity levels, species or even irrigation level. For an example in Rhodes grass (Katambora) under 5 dS/m salt level, it has 2.55% at (Irrigation 1 gal/hr), and 2.53 % at (Irrigation 1.3 gal/hr). In Rhodes grass (Claide) and under 10 dS/m salt level it was 2.94% at (Irrigation 1 gal/hr) and 2.99% at (Irrigation 1.3 gal/hr). In general, Cl% in all of the cultivars and under the three salinity levels considered high (the normal level not to exceed 0.3 %), and also there is no difference between the cultivars under different salinity level or irrigation level.

Pessarakeli, 1994 mentioned that "cell membranes are permeable to water but not to most solutes. When the external solute concentration is greater (or smaller) than the internal, water tends to move out of the cell. In medium or higher osmotic pressure cytoplasm will lose water and shrink away from the cell wall. Conversely, increasing the internal salt concentration too far results in the inhibition of many enzymes. The secret to adapting to high osmotic pressure is the use of compatible solutes. Certain solutes even in high concentrations do not inhibit enzyme function, the most common being glutamine, and prolin." Statistical analysis is not available, since there is no replicate of the tests.

7. K/NA ratio:

Table (121): K/Na Ratio in the cultivars tissue at three salinity levels

Species / Salt level	Rhodes 1 (Katambora)		Rhodes 2 (Claide)		Rhodes 3 (Pioneer)		Panicum 1 (Green)		Panicum 2 (Gatton)	
	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr	Ir 1 gal/hr	Ir 1.3 gal/hr
5 dS/m	1.09	1.08	1.58	0.7	1	1.3	2.66	6.01	1.37	1.49
10 dS/m	1.18	0.98	1.27	1.08	0.75	0.92	4.225	17.03	1.51	1.45
15 dS/m	1.13	1.68	0.88	0.91	0.94	0.86	3.59	4	1.33	1.31

The K/Na ratio table shows that it was not being affected by salinity except for Panicum species (Green) which was high. For example, K/Na ratio in 15 dS/m was 1.13 % at irrigation (1 gal/hr) in species Rhodes (Katambora), while at the same level of salinity its values were 1.33 % at irrigation (1.3 gal/hr) at Panicum species (Gatton).

Soil profile salinity discussion

Table (122): Salinity percentage in the soil profiles at low irrigation water salinity 1 (5 dS/m)

Replicate	Irrigation	Profile depth (cm) from the ground level	Salinity level (dS/m)
1	1 gal/hr	30	1.5
		60	0.6
	1.3 gal/hr	30	2
		60	0.9
2	1 gal/hr	30	1.9
		60	0.86
	1.3 gal/hr	30	1.8
		60	1.1
3	1 gal/hr	30	1.84
		60	1.14
	1.3 gal/hr	30	1.76
		60	1.24

Table (123): Salinity percentage in the soil profiles at medium irrigation salinity 2 (10 dS/m)

Replicate	Irrigation	Profile depth (cm) from the ground level	Salinity level (dS/m)
1	1 gal/hr	30	1.88
		60	1.9
	1.3 gal/hr	30	1.84
		60	1.82
2	1 gal/hr	30	1.85
		60	2.2
	1.3 gal/hr	30	1.84
		60	1.64
3	1 gal/hr	30	1.24
		60	1.32
	1.3 gal/hr	30	1.68
		60	1.34

Table (124): Salinity percentage in the soil profiles at high salinity 3 (15 dS/m)

Replicate	Irrigation	Profile depth (cm) from the ground level	Salinity level (dS/m)
1	1 gal/hr	30	3
		60	1.8
	1.3 gal/hr	30	3.54
		60	3.8
2	1 gal/hr	30	3.6
		60	4
	1.3 gal/hr	30	3
		60	1.3
3	1 gal/hr	30	3.48
		60	1.9
	1.3 gal/hr	30	1.52
		60	3.62

By comparing the different salinity concentrations of different soil profile as mentioned in tables no. (11,12, and 13) there was no difference between salinity 5 dS/m and salinity 10 dS/m. Less salinity can be found with depth, because the soil works as a natural filter and decreases the salinity. There was a difference between salinity 15 dS/m and the rest of the salinities (5 dS/m and 10 dS/m).

Comparison between the three cuts

In this section cuts will be compared together n the things which are really significant, or highly significant items "SPECIES" by using the LSD tables for each one of them. By going back to the "ANOVA" tables provided for each cut (Tables no. 14, 37, 61), the most item which has difference (some times highly significant) is the species, and represent which but for there numbers is best in representing the effect of salinity, and these items are:-

- **Plant Height (cm):**

Table (125): LSD for the plant height (cm) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Green	108.33	115	100	**107.77 a**
	Rhodes Callide	115	100	105	**106.66 a**
	Rhodes Katambora	108.33	96.66	100	**101.66 ab**
	Rhodes Pioneer	101.66	96.66	100	**99.44 b**
	Panicum Gatton	95	98.33	79.16	**90.83 c**
Cut no. (3)	Panicum Green	135.5	130.16	125.66	**130.44 a**
	Rhodes Katambora	100	98.33	98.33	**98.88 b**
	Rhodes Callide	83.33	81.66	71.66	**78.88 c**
	Rhodes Pioneer	70	78.83	65	**71.27 c**
	Panicum Gatton	75.83	65	62.5	**67.77 c**
Cut no. (4)	Panicum Green	138.33	103.33	61.33	**100.99 a**
	Rhodes Pioneer	77.5	82.33	77.5	**79.11 b**
	Rhodes Katambora	82.5	82.5	66.66	**77.22 bc**
	Rhodes Callide	80	80	60.83	**73.61 bc**
	Panicum Gatton	75	69.16	70	**71.38 c**

Columns followed by the same letter are non-significant at level 0.05

As per the above LSD table, results showed that cut no (2) was the best in producing the best plant height, and the entire cut has a high significant difference. For example, species 3 (Rhodes grass: Pioneer) values were 99.44 cm, 71.27 cm, and 79.11 cm at cut no 2, 3, and 4 respectively, it also shows that plant height was not affected because of the salinity (as it shows) in all of the cuts.

While species 4 (Panicum grass: Green) showed that best result was in cut no (3), and it also showed that it was not affected by salinity when its height was 135.5 cm, 130.16 cm, and 125.66 cm in salinity 5, 10, and 15 dS\m respectively in cut no (3).

Total tiller (no.):

Table (126): LSD for the Total tiller (no.) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Pioneer	634.95	471.95	527.73	**544.88 a**
	Panicum Gatton	586.15	357.75	565.96	**503.29 a**
	Rhodes Callide	399.68	443.38	337.6	**393.56 b**
	Rhodes Katambora	429.01	307.8	417.56	**384.79 b**
	Panicum Green	318.61	313.6	271.11	**301.11c**
Cut no. (3)	Rhodes Pioneer	503.55	440.8	381.88	**442.07 a**
	Rhodes Katambora	361.45	393.06	476.43	**410.31 a**
	Panicum Gatton	405.05	412.66	395.11	**404.28 ab**
	Rhodes Callide	317.35	356	380.56	**351.31 bc**
	Panicum Green	366.68	298.7	257.41	**307.59 c**
Cut no. (4)	Rhodes Pioneer	306.35	392.36	442.06	**380.26 a**
	Rhodes Callide	470.76	338.23	318	**375.67 a**
	Panicum Green	345.55	509.95	201	**352.16 a**
	Rhodes Katambora	304.51	335.73	361.86	**334.03 a**
	Panicum Gatton	351.36	263.71	385.01	**333.36 a**

Columns followed by the same letter are non-significant at level 0.05

Above LSD shows that species in cut no (3) has got the heighest means value for the totaltiller no when comparing it with cut 3 or 4. meanwhile, the entire cut has got highly significant difference, except for cut no (4) which ahs non-significant difference between all of the species. Although, species 3 (Rhodes grass: Pioneer) shows clearly that it was not affected due to salinity increasing in cut no (4) when it produced 306.35 no, 392. 36 no, and 442.06 no in salinity no 5, 10, and 15 dS/m respectively. Also, in cut no (4) species 2 (Rhodes grass: Callide) showed decreasing in total tiller no between the salinities (significant difference) when it result was 470.76 no, 338.23 no, and 318 no, respectively.

Leaf length (cm):

Table (127): LSD for the Leaf length (cm) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Katambora	38.26	43.68	38.75	**40.23 a**
	Rhodes Callide	38.76	38.71	38.2	**38.55 a**
	Rhodes Pioneer	40.01	38.3	37.15	**38.48 a**
	Panicum Gatton	37.63	44.56	29.71	**37.3 a**
	Panicum Green	30.43	30.9	26.91	**29.417 b**
Cut no. (3)	Rhodes Katambora	51.21	47.53	44.63	**47.79 a**
	Rhodes Callide	43.03	39.6	37.98	**40.2 b**
	Rhodes Pioneer	42.36	36.4	35.3	**38.02 bc**
	Panicum Gatton	39.81	32.75	33.65	**35.4 c**
	Panicum Green	26.81	25	24.41	**25.4 d**
Cut no. (4)	Rhodes Katambora	37.95	35.93	36.31	**36.73 a**
	Panicum Gatton	34.13	37.1	33.36	**34.86 ab**
	Rhodes Callide	36.4	33.31	28.88	**32.86 bc**
	Rhodes Pioneer	31.26	30.76	29.01	**30.34 cd**
	Panicum Green	26.76	25.53	32.01	**28.1 d**

Columns followed by the same letter are non-significant at level 0.05

Above results showed that, cut no (3) was the best in producing the highest leaf length, although cut no (4) shows a very small difference in the means. All of the showed highly-significant difference between the cuts, especially cut no (3). For example, when comparing the species means together in cut no (3), difference in the menas can be noticed, while when comparing the leaf length in each salinity level (in cut no 3) according to each species separately, the difference between the salinities is significance (log difference). When comparing the species in differenct cuts together, there was a difference between them. For example, species 5 (Panicum grass: Gatton) means values were 37.3 cm, 35.4 cm , and 34.86 cm in cut no 2, 3, and 4 separetely.

Internodes length (cm):

Table (128): LSD for the Internodes length (cm) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Callide	18.31	15.3	17.16	**16.92 a**
	Rhodes Pioneer	16.23	14	14.76	**15 ab**
	Rhodes Katambora	14.4	13.75	12.53	**13.56 bc**
	Panicum Gatton	11.08	13.2	13.86	**12.71 bc**
	Panicum Green	13.6	13.26	9.98	**12.28 c**
Cut no. (3)	Rhodes Callide	16.56	13.86	13.15	**14.52 a**
	Rhodes Katambora	13.8	14.26	12.93	**13.66 ab**
	Rhodes Pioneer	11.83	10.7	12.11	**11.54 b**
	Panicum Green	12.35	11.3	10.15	**11.26 b**
	Panicum Gatton	9.2	5.08	8.766	**7.68 c**
Cut no. (4)	Rhodes Pioneer	14.11	11.83	12.11	**12.68 a**
	Rhodes Katambora	13.86	11.26	10.81	**11.97 a**
	Rhodes Callide	12.36	10.81	10.81	**11.32 ab**
	Panicum Gatton	11.35	11.33	11.21	**11.29 ab**
	Panicum Green	11.21	11.15	7.6	**9.98 b**

Columns followed by the same letter are non-significant at level 0.05

Results from the above table shows that cut no (2) values were the best in producing the best internodes length between the cuts, and it also shows that the salinity did not have that much effect on the species. For example, species 1 (Rhodes grass: Katambora) values in cut no (2) were 14.4 cm, 13.75 cm, and 12.53 cm in salinity 5, 10, and 15 dS\m respectively. Comparing the species from different cuts showed that species 4 (Panicum grass: Green) values were 12.2 cm, 11.26 cm, and 9.98 cm in cuts no 2, 3, and 4 respectively.

Total fresh weight in $1m^2$ (g):

Table (129): LSD for the Total Fresh weight ($g/m^{2)}$ for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Gatton	1692.5	1260.2	980.3	**1311 a**
	Rhodes Callide	1437.46	1173.43	1071.23	**1227.37 a**
	Rhodes Katambora	1405.5	1087.9	1148.3	**1213.9 a**
	Rhodes Pioneer	1159.83	1081.13	936.26	**1059.07 b**
	Panicum Green	1032.5	886.93	879.4	**932.94 c**
Cut no. (3)	Rhodes Katambora	1596	2281.83	1816	**1897.94 a**
	Panicum Green	1495	2390.33	1622	**1835.77 ab**
	Panicum Gatton	1175	1387	2503.6	**1688.3 ab**
	Rhodes Callide	1234	1741	1847.9	**1607.6 bc**
	Rhodes Pioneer	871	2391.66	1055.1	**1439.2 c**
Cut no. (4)	Panicum Green	1922	2210.33	576	**1569.44 a**
	Panicum Gatton	1197	1399.66	1808	**1468.22 a**
	Rhodes Katambora	1360	1426.33	1329	**1371.77 a**
	Rhodes Callide	1503	1364	1170	**1345.66 a**
	Rhodes Pioneer	1218	1430.33	1211.33	**1286.55 a**

Columns followed by the same letter are non-significant at level 0.05

The LSD table above showed that cut no (3) values were the heights between all of the cuts, and it also showed that some species was no affected due to salinity although it was increasing in the fresh weight while the salinity increases, and was affected significantly. For example, species 3 (Rhodes grass: Pioneer) values in cut no (2) were 1159.83 g, 1081.13 g, and 936.26 g in salinity 5, 10, and 15 dS/m.

On the other hand, species 5 (Panicum grass: Gatton) values no (3) were 1175 g, 1387 g, and 2503.6 g at salinity levels 5, 10, 15 dS/m respectively.

Total dry weight in $1m^2$ (g):

Table (130): LSD for the Total Dry weight (g)/m^2 for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Callide	331.43	279.1	282.7	**297.74 a**
	Panicum Gatton	364.9	291.23	231.03	**295.72 a**
	Rhodes Katambora	335.16	278.16	261.16	**291.50 ab**
	Rhodes Pioneer	310.4	254.9	237.06	**267.46 ab**
	Panicum Green	314.5	213.53	252.7	**260.24 b**
Cut no. (3)	Rhodes Katambora	672.66	737.53	627.56	**679.25 a**
	Panicum Green	447.66	591.66	386	**475.11 b**
	Rhodes Callide	394.66	476.9	497.1	**456.22 b**
	Rhodes Pioneer	351	625.33	329.5	**435.28 b**
	Panicum Gatton	498.66	368.43	415.33	**427.48 b**
Cut no. (4)	Panicum Green	667	753.66	295.83	**565.50 a**
	Panicum Gatton	378	563	500	**480.33 b**
	Rhodes Katambora	465	504.8	446.33	**472.04 b**
	Rhodes Pioneer	363	519.43	394	**425.47 bc**
	Rhodes Callide	490	372.8	331	**397.93 c**

Columns followed by the same letter are non-significant at level 0.05

Results showed that cut no (3) values were the heights in producing the total dry weight, and it also shows that some species was affected due to salinity, although in other cases it was affected significantly. For example, species 2 (Rhdoes grass: Callide) values in cut no (4) were 490 g, 372.8 g, and 331 g in salinity levels 5, 10, and 15 dS/m respectively.

Leaves dry weight in $1m^2$ (g):

Table (131): LSD for the Leaves dry weight (g)/m^2 for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Gatton	217.73	131.65	128.2	**159.19 a**
	Rhodes Katambora	122.76	143.58	100.11	**122.15 b**
	Rhodes Callide	112.6	124.15	113.68	**116.81 b**
	Rhodes Pioneer	125.28	122.91	100.85	**116.35 b**
	Panicum Green	102.08	74.016	79.13	**85.07 c**
Cut no. (3)	Rhodes Katambora	437.88	481.48	456.88	**458.75 a**
	Rhodes Callide	312.36	364.06	324.63	**333.68 b**
	Panicum Gatton	301.18	330.18	337.35	**322.9 b**
	Rhodes Pioneer	304.6	412.08	244.66	**320.45 b**
	Panicum Green	154.1	136.11	116.28	**135.5 c**
Cut no. (4)	Panicum Gatton	248.38	256.21	264.93	**256.51 a**
	Rhodes Katambora	189.016	213.9	255.86	**219.59 ab**
	Rhodes Callide	254.16	171.6	205.2	**210.32 bc**
	Panicum Green	221.66	212.75	129.55	**187.98 c**
	Rhodes Pioneer	148.46	196.05	227.21	**190.58 c**

Columns followed by the same letter are non-significant at level 0.05

Results showed that cut no (3) values were the best in producing the highest leaves dry weight according to the means values. These results also shows that there was highly significance difference between the species, and also there were increasing in leaves dry weight while the salinity is increasing. For example, species 5 (Panicum

grass: Gatton) means values were 159.19 g, 322.9 g, 256.51 g at cut no 2, 3, and 4 respectively.

However species 1 (Rhdoes grass: Katambora) values in cut no (4) were 189.01 g, 213.0 g, 255.86 g at salinity levels 5, 10, and 15 dS/m respectively, and it also shows that leaves dry weight was increasing while the salinity increases from level to another, which means that the plant is highly salt tolerant plant.

Stem dry weight in $1m^2$ (g):

Table (132): LSD for the stem dry weight (g)/m^2 for different cuts

The cut no.	Species	Salinity			mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Green	212.28	212.01	175.71	**200.01 a**
	Rhodes Callide	218.73	205.11	144.16	**189.33 ab**
	Rhodes Katambora	198.01	136.8	158.4	**164.4 b**
	Rhodes Pioneer	210.86	153.08	125.68	**163.21 bc**
	Panicum Gatton	141	151.06	115.26	**135.77 c**
Cut no. (3)	Panicum Green	258.11	387.16	266.81	**304.03 a**
	Rhodes Katambora	174	186.91	159.28	**173.4 b**
	Rhodes Callide	85.31	169.78	141.75	**132.28 bc**
	Rhodes Pioneer	85.25	183.51	88.816	**119.19 c**
	Panicum Gatton	107.11	51.81	169.96	**109.63 c**
Cut no. (4)	Panicum Green	436.83	548.01	59.03	**347.96 a**
	Rhodes Katambora	308.46	291.68	165.4	**255.18 b**
	Rhodes Pioneer	214.11	275.45	177.11	**222.22 b**
	Rhodes Callide	235.75	224.65	196.96	**219.12 b**
	Panicum Gatton	181.06	237.56	200.21	**206.28 b**

Columns followed by the same letter are non-significant at level 0.05

Results showed that cut no (4) values were the highest in producing the dry stem weight. Although, the entire cut shows highly significant difference between the species, and the least which has the high significance was cut no (4). On the other hand species 1

(Rhodes grass: Katambora) is cut no (4) has highly significance difference in the stem dry weight values, for example it got 308.46 g, 291.68 g, and 165.4 at salinity 5, 10, 15 dS/m respectively.

Leaves fresh weight in $1m^2$ (g):

Table (133): LSD for the Leaves fresh weight (g)/m^2 for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Gatton	908.81	512.73	582.56	**668.03 a**
	Rhodes Callide	457.38	493.05	456.7	**469.04 b**
	Rhodes Pioneer	436.26	467.58	395.96	**433.27 b**
	Rhodes Katambora	462.3	432.78	404.35	**433.14 b**
	Panicum Green	381.08	317.2	258.11	**318.8 c**
Cut no. (3)	Rhodes Katambora	1031.11	1437.48	1356.18	**1274.92 a**
	Rhodes Callide	926.316	1236.9	1465.23	**1209.48 a**
	Panicum Gatton	626.48	1120.5	1131.96	**959.18 b**
	Rhodes Pioneer	764.816	1048.95	747.78	**853.85 b**
	Panicum Green	546	470.86	537.7	**518.18 c**
Cut no. (4)	Panicum Gatton	681.51	695.11	824	**733.54 a**
	Rhodes Katambora	571.65	724.56	751.15	**682.45 ab**
	Rhodes Pioneer	526.45	640.4	636.43	**601.09 bc**
	Rhodes Callide	622.91	610.18	506.1	**579.73 cd**
	Panicum Green	595.75	602.66	230.56	**476.32 d**

Columns followed by the same letter are non-significant at level 0.05

Results showed that cut no (3) was the best in producing the heighest leaves fresh weight. More over, species 1 (Panicum grass: Gatton) values were 681.51 g, 695.11 g, and 824 g at cut no (4) and at salinity 5, 10, and 15 ds/m respectively. The previous numbers shows that these species produced more leaves fresh weight at salinity 15 dS/m than at salinity 5 dS/m, which approves that this species is a salt tolerant plant.

Stem fresh weight in $1m^2$ (g):

Table (134): LSD for the stem fresh weight (g) /m^2 for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Callide	770.36	854.85	722.01	**782.41 a**
	Rhodes Katambora	854.36	648.48	777.9	**760.25 a**
	Panicum Gatton	858.28	737.25	518.36	**704.63 ab**
	Panicum Green	727.43	586.45	709.06	**674.31 ab**
	Rhodes Pioneer	723.28	586.61	530.35	**613.41 b**
Cut no. (3)	Panicum Green	914.2	1548.55	957.15	**1139.96 a**
	Rhodes Katambora	565.98	1139.4	571.06	**758.81 b**
	Panicum Gatton	510.96	492.93	632.78	**545.56 bc**
	Rhodes Callide	301.56	504	585.01	**463.52 c**
	Rhodes Pioneer	287.71	701.11	307.21	**432 c**
Cut no. (4)	Panicum Green	1386.53	1638.53	167.66	**1064.24 a**
	Panicum Gatton	607.65	784.98	901.11	**764.58 b**
	Rhodes Katambora	875.9	842.4	590	**769.43 b**
	Rhodes Pioneer	688.96	825.9	548.33	**687.73 b**
	Rhodes Callide	799.95	732.51	522.46	**684.97 b**

Columns followed by the same letter are non-significant at level 0.05

Results showed that cut no (4) was the best in producing the stem fresh weight. Also results showed that all of cuts have highly significance difference between the species, although in some species it was reducing in stem fresh weight significantly when applying the higher level of salinity. For example, species 2 (Rhodes grass: Callide) values were 799.95 g, 732.51 g, and 522.46 respectively.

Leaf area in $1m^2$ (cm^2):

Table (135): LSD for the Leaf area m^2 (cm^2) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Panicum Gatton	48475.85	14209.78	10740.7	**24475.44 a**
	Panicum Green	20523.42	13446.1	13944.42	**15971.31 b**
	Rhodes Pioneer	16054.02	19333.52	12467.8	**15951.78 b**
	Rhodes Callide	16238.87	15645.6	15740.72	**15875.06 b**
	Rhodes Katambora	15155	15087.78	12858.33	**14367.04 b**
Cut no. (3)	Rhodes Katambora	31396.23	46393.95	52910.35	**43566.84 a**
	Rhodes Callide	22688	44351.55	46778.97	**37939.51 b**
	Panicum Gatton	21274.43	35058.7	33436.22	**29923.12 c**
	Rhodes Pioneer	23490.51	36027.75	23733.78	**27750.68 c**
	Panicum Green	10456.31	11227.58	8790.86	**10158.26 d**
Cut no. (4)	Panicum Gatton	19935.23	25323.15	37314	**27524.13 a**
	Rhodes Katambora	15147.92	19393.55	23326.57	**19289.34 b**
	Rhodes Callide	19729.2	20067.07	18929.6	**19575.29 b**
	Rhodes Pioneer	9923.33	19148.7	20712.35	**16594.79 b**
	Panicum Green	8941.26	9782.23	5826.15	**8183.21 c**

Columns followed by the same letter are non-significant at level 0.05

Results showed that the highest leaf area values were in cut no (3), also the plant showed highly significant in the means values. Some species in cut no (2) showed highly significant (drastically decreasing) when treated with salinity. For example, in cut o 2 species 5 (Panicum grass: Gatton) values were 48475.85 cm^2, 14209.78 cm^2, and 10740.7 cm^2, in salinity levels 5, 10, and 15 dS/m respectively.

Fertile tillers (no.):

Table (136): LSD for the fertile tillers (no.) for different cuts

The cut no.	Species	Salinity			Mean
		5 dS/m	10 dS/m	15 dS/m	
Cut no. (2)	Rhodes Pioneer	177.2	137.06	123.91	**146.06 a**
	Panicum Green	90.1	105.98	136.33	**110.81 b**
	Rhodes Katambora	123.66	97.2	70.216	**97.03 bc**
	Rhodes Callide	71.9	125.56	93.2	**96.89 bc**
	Panicum Gatton	0	100.61	125.93	**75.52 c**
Cut no. (3)	Panicum Green	104.73	76.05	67.21	**82.66 a**
	Rhodes Callide	46.816	74.516	100.08	**73.8 a**
	Rhodes Katambora	63.38	34.48	41.58	**46.48 b**
	Rhodes Pioneer	45.61	54.1	22.46	**40.72 b**
	Panicum Gatton	53.71	2.25	45.51	**33.82 b**
Cut no. (4)	Rhodes Pioneer	103.35	72.4	136.85	**104.2 a**
	Rhodes Callide	78.66	135.61	70.66	**94.98 ab**
	Panicum Green	91.3	93.816	5.76	**65.79 bc**
	Rhodes Katambora	48.26	20.45	61.73	**43.48 cd**
	Panicum Gatton	9.816	11.56	58.86	**26.75 d**

Columns followed by the same letter are non-significant at level 0.05

Results showed that fertile tillers in cut no (2) was the highest betweent eh cuts. On the other hand, some species fertile tillers was increasing while the salinity increases, while other species was affected due to salnity. For example, at cut no (2) species 3 (Rhdoes grass: Pioneer) values were 177.2 no, 137.06 no, and 123.91 no at salinity levels 5, 10, and 15 dS/m respectively. Also, at cut no (3) species 2 (Rhodes grass: Callide) values were 46.81 no, 74.51 no, and 100.08 no at salinity levels 5, 10, and 15 dS/m respectively.

Conclusion

From all of the results obtained, and under the same conditions and circumstances, saline water and salty land are two issues which have to be considered together. My findings show that many experimental species shows encouraging results. It also showed that there was no difference in irrigation level (1 gal/hr and 1.3 gal/hr) in affecting the cultivars. All species in the experiment were treated with difference saline water levels (5 dS/m, 10 dS/m, and 15 dS/m). This proves that it can tolerate salinity, and to produce high yields while the salinity is also increasing.

Salty water for example, might be used to irrigate salt tolerant plants, and to produce animal feed, or even for other purposes as well. Results obtained out of the analysis of the plants tissues, has been compared with the international standards to clarify whether it is suitable for animal feeding or not. Fiber and ion analysis both showed that natural and chemical components were not affected by salinity level and all varieties were suitable for animal feeding.

The king of grasses used for this experiment are considered to be salt tolerant (like the Rhodes grass), and can live in harsh conditions. By using three different levels of salinity, and two different levels of irrigation amount, this experiment provided knowledge on how to use saline water, and to preserve fresh water. The experiment also showed that all of the cultivars have survived at high salinity levels, and even may tolerate high concentration of salty water if treated with.

Growth and productivity of five cultivars from the forage grasses (Rhodes Katambora, Rhodes Callide, Rhodes Pioneer, Panicum Green, and Panicum Gatton), were compared together at three levels of salinity (5 dS/m, 10 dS/m, and 15 dS/m). Chemical analysis and forage valuses were also compared. These kinds of grasses are considered to be one of the most important forage grasses in the region

According to the total dry weight at different cuts (table 130), results showed that under (5 dS/m) of salinity, Rhodes grass (Callide) values was heighest among Rhodes grasses cultivars. While at (10 dS/m), results showed that Rhodes grass (Katambora) (506.83 g) and Panicum grass (Green) was out performed others (519.61 g), at high salinity (15 dS/m), Rhodes grass Katambora was the best (445 g), and Panicum grass (Gatton) were the top performing cultivars. When comparing the protein percentage of the species results showed that Panicum grass (Gatton) has produced the best protein percentage at salinity (5 dS/m), 10 dS/m, and 15 dS/m respectively, and it also showed that the protein percentage was increasing, while the salinity increases from one level to another. On the other hand, results showed that the ash contesnt of the examined specie was not affected because of salinity in all of the species.

Results also showed that total dry weight under differencr cuts, at salinity (5 dS/m) Rhodes grass (Callide) values were 331.43 g, 394.66 g, and 490 g at cut no 2, 3, and 4, respectively, while when increasing the salnity to 15 dS/m, Rhodes grass (Katambora) values were 291.5 g, and 679.25 g, and 472.04 g respectively. The previous results showed that Rhodes grass (Katambora) was the best cultivars between all of the species, because of its high values in dry matter, its stability in the ash content, and its protein value.

It is concluded that at low salinity (5 dS/m), Rhodes grass (Callide) out performed very well. While at medium salinity (10 dS/mJ), and high salinity (15 dS/m), Rhodes grass (Katambora), and Panicum grass (Green) Pnicum were the most salt-tolerant and maintained acceptable levels of productivity red forage (Quality). These finding can be used as guidlines for selection of suitable cultivars for salt-affectred environment.

This study has covered the species and their performance under certain circumstances (salinity and irrigation level) while it was growing. Another experiment could be made by using some species on a bigger scale (on salty land for example) which will provide more information on how the people can take the benefit of the saline water, or salty land.

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ملخص البحث

تم إجراء البحث في المركز الدولي للزراعة الملحية بدبي وذلك لتحديد درجة تحمل الملوحة وإنتاجية بعض النباتات التي تنمو محليا (الرودس، البانيكم)، وذلك تحت درجتين من درجات الري (1 جالون/ ساعة و 1.3 جالون/ ساعة)، وكذلك ري النباتات بثلاثة درجات مختلفة من الملوحة (5dS/m-10dS/m-15dS/m)، حيث أمكن بهذه الطريقة توفير معلومات قيمة ومفيدة عن فعالية استخدام المياه وملوحة الأرض بعد فترة من الزمن, حيث امتدت فترة النجربة على ثلاث حشات متتابعة.

تم التدقيق -بين فترة وأخرى- على النباتات من ناحية النمو والإنتاج الخضري مع الأخذ بعين الإعتبار الأمور التالية: طول النبات، العدد الكلي للإشطاءات، طول الورقة، طول السلاميات، الوزن الكلي الرطب، الوزن الكلي الجاف، الوزن الكلي الرطب للأوراق، الوزن الكلي الرطب للسيقان، الوزن الكلي الجاف للأوراق، الوزن الكلي الجاف للسيقان، مساحة الأوراق، وعدد الإشطاءات الناضجة. تم تحديد نوعية العلف المنتج عن طريق تحليل المواد العضوية (البروتين-الألياف بنوعيها-الوزن الجاف للعينات-الوزن بعد الحرق)، وكذلك المواد غير العضوية مثل(Mg-Cl-Na-Ca-K). كما تم أخذ عينات من التربة على أعماق مختلفة (30 و 50 سم) لكي يتم التعرف عن قرب على تركيز الملوحة في تلك المنطقة، أخذت العينات من عدة مناطق مختلفة في الحقل وعلى فترات متباعدة، حيث تم تحليلها في المختبر

وتقدير نسبة الملوحة فيها، حيث تعطي النتائج المتحصل عليها على أرقام معينة يمكن من خلالها مقارنتها مع المقاييس العالمية في هذا المجال، وكذلك والتأكد من صلاحية المواد للإستهلاك الحيواني من عدمه. تبين من خلال النتائج المتحصل عليها ، أن بعض النباتات أثبتت بأنها متحملة للملوحة بدرجة كبيرة وقادرة على إنتاج نمو خضري جيد مع إرتفاع نسبة الملوحة سواء في الري أو في التربة. كما أثبتت النتائج المتحصل عليها أن العلف الناتج من التجربة أثبت جودته وصلاحيته لتغذية الحيوان طبقاً للمقاييس العالمية. وبناءاً على النتائج المشجعة أوصي أن تقوم الجهات البحثية بتكرار نفس التجربة على نطاق أوسع وذلك بزيادة عدد الأصنف في التجربة أو بعمل مساحة أكبر من التجربة وزيادة درجات الملوحة في الري وذلك لكي يتم الحصول على نتائج أوسع وأشمل يمكن تطبيقها في المستقبل على نطاق زراعي يستفيد منه المزارعين في شتى البقاع.

جامعة الإمارات العربية المتحدة

عمادة الدراسات العليا

برنامج ماجستيرعلوم البيئة

تأثير الري بالمياه المالحة على النمو والنوعية لبعض النباتات المقاومة للملوحة تحت ظروف دولة الإمارات العربية المتحدة

رسالة مقدمة من الطالب

محمود عبد الرزاق بالسلاح

إلى

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استكمالاً لمتطلبات الحصول على درجة الماجستير في علوم البيئة

الدكتور/ أحمد المعصوم قسم زراعة الأراضي القاحلة كلية نظم الأغذية جامعة الإمارات العربية المتحدة	د. فاطمة الأنصاري قسم الأحياء كلية العلوم جامعة الإمارات العربية المتحدة	د. عبد الله الدخيل المركز الدولي للزراعة الملحية	د. شعيب إسماعيل المركز الدولي للزراعة الملحية

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